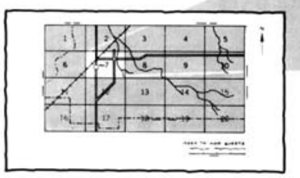
Soil Survey of

# Reeves County, Texas

United States Department of Agriculture Soil Conservation Service
in cooperation with
Texas Agricultural Experiment Station

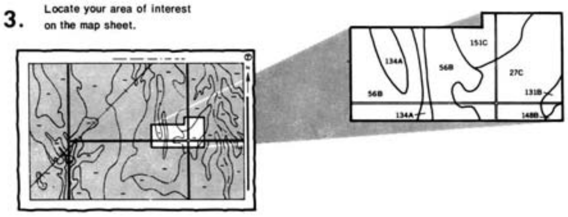
# HOW TO USE THIS SOIL SURVEY

1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

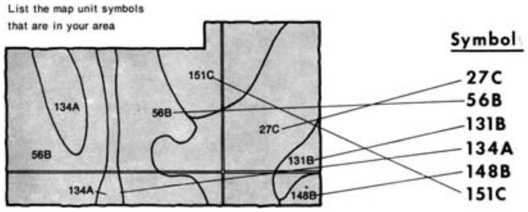



2. Note the number of the map sheet and turn to that sheet.

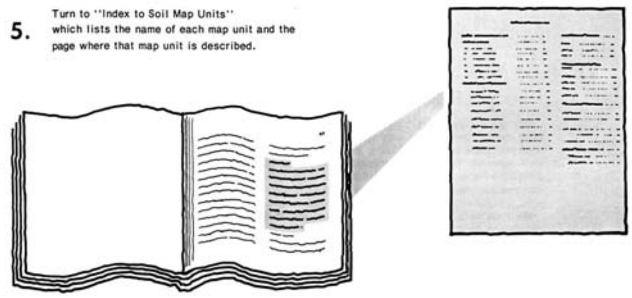
3. Locate your area of interest on the map sheet.



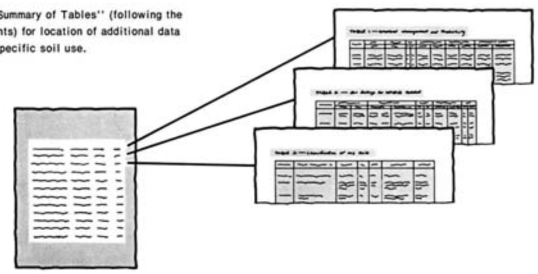

4. List the map unit symbols that are in your area




5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1968-76. Soil names and descriptions were approved in 1976. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Upper Pecos Soil and Water Conservation District and the Toyah-Limpia Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

**Cover: An area of Brewster association, hilly, in the Igneous Hill and Mountain range site.**

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Issued June 1980

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# Foreword

This soil survey contains information that can be used in land-planning pro-grams in Reeves County, Texas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

George C. Marks
State Conservationist
Soil Conservation Service

# SOIL SURVEY OF REEVES COUNTY, TEXAS

**By Hubert B. Jaco, Soil Conservation Service**

**Soils surveyed by Hubert B. Jaco and Wesley L. Miller, Soil Conservation Service. Jerry L. Rives, William Dittemore, August Turner, and Alan Kosse, Soil Conservation Service, assisted in the field mapping.**

**United States Deportment of Agriculture, Soil Conservation Service, in cooperation with Texas Agricultural Experiment Station**

Reeves County is in the western part of Texas. It is in the Trans-Pecos Land Resource Area. The county measures about 88 miles from north to south and about 64 miles from east to west. It has a total area of 2,608 square miles, or 1,669,120 acres. There are 7,680 acres of water, mainly in Red Bluff and Balmorhea Lakes. The land surface is nearly level to undulating in most of the county. The extreme southern and southwestern part is hilly to mountainous. The elevation ranges from 2,500 feet along the Pecos River to 5,000 feet in the mountains. Drainage is to the Pecos River or to Toyah Lake.

Ranching and irrigated farming are the main enterprises in the county. Cattle feeding is another important enterprise. According to the Conservation Needs Inventory (3), in 1967 there was about 1,480,509 acres in rangeland and 159,704 acres in irrigated cropland. However, the irrigated acreage has decreased sharply to about 25,000 acres. About 12,268 acres is in developed areas.

Beef cattle make up the principal ranching stock in the county. Cotton, grain sorghum, barley, alfalfa, and wheat are the main irrigated crops. Onions, cantaloupes, and cabbages are also grown.

Important nonfarming enterprises include oil and gas production and exploration, automotive proving grounds, and sulfur production.

Most of the soils in the county formed in valley fill sediment and are light colored, loamy, and dry. Unprotected areas are subject to soil blowing and water erosion.

An earlier survey of Reeves County was published in 1926 (4). The present survey updates this earlier survey and provides additional information and more detailed maps.

## General nature of the county

Carlton R. Blackwell, district conservationist, Soil Conservation Service, assisted in writing this section.

This section gives general information concerning the county. Settlement and population, farming, natural re-sources, and climate are briefly discussed.

### Settlement and population

Reeves County was formed in 1883 from a part of Pecos County. It was organized in 1884, and named for Confederate Colonel George R. Reeves.

The population of Reeves County in 1890 was 1,247. In 1970 it was 16,526. The city of Pecos is the county seat. The population of Pecos in 1890 was 393. In 1970 it was 12,682. The estimated 1976 population of Pecos was 14,143.

## Farming

The main farming enterprises in Reeves County are livestock production and irrigated crop production. The major irrigated crops are cotton, small grain, forage and grain sorghum, alfalfa, and vegetables. The acreage planted to these crops in the county has declined be-cause of the high input cost of producing irrigated crops.

About 25,000 acres is currently irrigated. This acreage is primarily devoted to the production of grain and forage crops that are used locally by feedlots and a dairy.

More than 90 percent of the land in the county is rangeland. Livestock operations are primarily cow-calf. Yearlings utilize forage produced by seasonal grazing.

## Natural resources

The soil and underground irrigation water are two of the county's important natural resources. Natural flowing springs supply water for about 7,000 irrigated acres in the southern part of the county. Irrigation wells supply water for another 18,000 irrigated acres.

Minerals, natural gas, and natural gas liquids have been discovered and developed. The companies that explore and develop these resources provide an important source of employment.

## Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Summers are hot and winters are cool in Reeves County. Winter days are fairly warm, although the temperature drops below freezing most nights each winter. Rainfall is scant in most months but is heaviest in summer, when scattered thunderstorms develop in the moist air which occasionally sweeps inland from the Gulf of Mexico. Snow cover in winter is not persistent and is generally confined to higher elevations.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Pecos, Texas in the period 1951 to 1975. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table

3 provides data on length of the growing season.

In winter the average temperature is 46 degrees F, and the average daily minimum temperature is 29 degrees. The lowest temperature on record, which occurred at Pecos on January 11, 1962, is 9 degrees. In summer the average temperature is 83 degrees, and the average daily maximum temperature is 99 degrees. The highest recorded temperature, which occurred on June 29, 1968, is 118 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 6 inches, or 70 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than

4 inches. The heaviest 1-day rainfall during the period of record was 3 inches at Pecos on July 26, 1959. Thunderstorms occur on about 40 days each year, and most occur in summer.

Snowfall is rare. In 70 percent of the winters, there is no measurable snowfall. In 20 percent, the snowfall, usually of short duration, is more than 2 inches. The heaviest 1-day snowfall on record was more than 6 inches.

The average relative humidity in mid afternoon is about 40 percent. Humidity is higher at night, and the average at dawn is about 70 percent. The prevailing wind is from the south-southwest. Average windspeed is highest, 13 miles per hour, in April.

## How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nation-wide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photo-graphs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland managers, engineers, planners, developers and builders, home buyers, and others.

## General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The nine soil map units in Reeves County have been grouped into three general kinds of landscapes for broad interpretive purposes. Each of the broad groups and the map units in it are described on the following pages.

## Dominantly well drained soils of the hills, ridges, and mountains

This group of map units makes up about 55 percent of the county. The major soils of this group are Delnorte, Reakor, Lozier, Ector, and Brewster soils. Most of these soils have a gravelly or stony surface layer. Reakor soils have a loamy surface layer. Delnorte soils are shallow over strongly cemented caliche. Ector and Lozier soils are shallow over limestone bedrock. Brewster soils are shallow over igneous bedrock. All of the soils are well drained.

These soils are used as rangeland except for developed areas in the towns of Toyah and Orla. Native range grasses on these map units include blue grama, sideoats grama, black grama, bush muhly, cane bluestem, and burrograss. Woody plants such as creosotebush, mesquite, and juniper have encroached on most areas. The juniper is mainly on Ector soils.

Most of the soils of these map units are not suited to cropland because of shallow soil depth, gravel, stones, slope, and very low available water capacity. Reakor soils are suited to irrigated cropland where water of good quality and sufficient quantity is available.

Most of these soils have low potential for urban uses because of shallow depth to bedrock or to strongly cemented caliche. Reakor soils have moderate shrink-swell potential and are highly corrosive to uncoated steel. Most of these soils have low potential for recreational uses because of small and large stones and dusty soil surfaces.

#### 1. Delnorte-Reakor

*Shallow and deep, nearly level to rolling, gravelly and loamy soils; on hills and ridges*

This map unit consists of soils that have 0 to 12 percent slopes**.** It makes up about 48 percent of the county. It is about 33 percent Delnorte soils, 20 percent Reakor soils, and 47 percent other soils.

The nearly level to rolling Delnorte soils are on up-lands. Slopes range from 2 to 12 percent. Typically, Delnorte soils have a surface layer of pale brown, calcareous gravelly loam about 5 inches thick. The next layer, to a depth of 12 inches, is very pale brown very gravelly loam. From a depth of 12 to 32 inches is very pale brown strongly cemented caliche. The underlying layer, to a depth of 80 inches, is light gray gravelly loam.

The nearly level to gently sloping Reakor soils are on uplands. Slopes are 0 to 3 percent. Typically, Reakor soils have a surface layer of light brown, calcareous loam about 8 inches thick. The next layer, to a depth of 24 inches, is light brown, calcareous clay loam that has a few threads of calcium carbonate. The next layer, to a depth of 36 inches, is pink clay loam that has concretions, soft masses, and threads of calcium carbonate. The underlying layer, to a depth of 60 inches, is pink clay loam. These soils are calcareous and moderately alkaline throughout.

Several other soils are in this map unit. The deep, loamy, nearly level to gently sloping Hoban and Monahans soils are on uplands. The deep, loamy, nearly level Hodgins soils are along drainageways and on terraces. The moderately deep, nearly level Reeves soils are on uplands. The shallow, loamy, nearly level to sloping Halloman and Upton soils; the shallow, very gravelly, loamy, hilly Mierhill soils; and the deep, very gravelly, gently sloping to rolling Nickel soils are on uplands.

The soils in this map unit are used as rangeland. Small areas are used for housing and commercial purposes. The towns of Orla and Toyah are in areas of this map unit.

Delnorte soils are not suited to irrigated cropland be-cause of high gravel content and shallow depth to strongly cemented caliche. Where water of sufficient quantity and good quality is available, Reakor soils have high potential for irrigated cropland.

The potential of Delnorte soils for rangeland is low because of shallow soil depth; the potential of Reakor soils is medium. The potential of Delnorte and Reakor soils for wildlife habitat is low.

Delnorte soils have low potential for most urban uses because of depth to strongly cemented caliche, gravel content, and slope. Reakor soils have medium potential for most urban uses. The shrink-swell potential is the main limitation. The potential for recreational uses is low in Delnorte soils because of gravel, and medium in Reakor soils because of the dusty soil surface.

**2. Lozier-Ector**

*Shallow and very shallow, rolling to steep, stony and very gravelly loamy soils; on limestone hills*

This map unit consists of soils that have 5 to 35 percent slopes. It makes up about 4 percent of the county. It is about 37 percent Lozier soils, 27 percent Ector soils, and 36 percent other soils and Rock outcrop.

The rolling to steep Lozier soils are on limestone hills. Slopes are 5 to 35 percent. As much as 20 percent of the surface is covered with stones. Typically, Lozier soils have a surface layer about 11 inches thick of very gravelly loam that has about 40 percent by volume limestone gravel. It is pale brown in the upper part and light gray in the lower part. This layer rests abruptly on fractured limestone bedrock.

Ector soils are on limestone hills. Slopes are 5 to 30 percent. Typically, Ector soils have a surface layer of calcareous very gravelly loam about 9 inches thick that is grayish brown in the upper part and brown in the lower part. This layer is about 50 percent limestone fragments. As much as 20 percent of the surface is covered with stones. The underlying layer is fractured limestone bed-rock.

Some other soils and exposures of Rock outcrop are in this map unit. The limestone Rock outcrop occurs as almost vertical scarps and bare rock exposures on hills. The shallow, gravelly, gently sloping and sloping Upton soils are on foot slopes. The deep, gravelly, gently sloping and sloping Sanderson soils are on fans and terraces. The deep, nearly level to gently sloping Hodgins and Reakor soils are in valleys and along drainageways.

The soils of this map unit are used as rangeland. They are not suited to irrigated cropland, hayland, pastureland, or orchards because of depth to bedrock, slope, and stones. The potential for growing native range plants is low because very low rainfall and very low available water capacity limit forage production. The potential for wildlife habitat is low.

These soils have low potential for most urban and recreational uses because of slope, depth to bedrock, and stones.

**3. Brewster**

*Shallow and very shallow, hilly and steep, stony and very gravelly loamy soils; on igneous hills and mountains*

This unit consists of soils that have slopes of 10 to 40 percent or more. It makes up about 3 percent of the county. It is about 53 percent Brewster soils and 47 percent other soils and Rock outcrop.

Brewster soils are on hills and mountains. Slopes range from 10 to 40 percent or more. Typically, Brewster soils have a surface layer of mildly alkaline, calcareous, dark grayish brown very gravelly loam about 6 inches thick. As much as 20 percent of the surface is covered with stones. The substratum is fractured igneous bedrock.

Some other soils and exposures of Rock outcrop are in this unit. The deep, very cobbly Limpia soils; deep, cobbly Verhalen soils; and shallow, very gravelly Mitre soils are nearly level to sloping soils on foot slopes and fans at the base of hills and mountains. The shallow, very gravelly Mierhill soils are on hills. The clayey Phantom soils and very gravelly Rockhouse soils are deep, nearly level to sloping soils in drainageways. Rock outcrop is the almost vertical scarps and bare rock exposures on hills and mountains.

The soils of this map unit are used as rangeland. They are not used as either irrigated or nonirrigated cropland, pastureland, or hayland because of shallow rooting depth, slope, small stones, and Rock outcrop.

The potential for rangeland is low, although yields of short and mid grasses are good during favorable years.

These soils have low potential for urban and recreational uses because of slope, depth to bedrock, Rock outcrop, and small and large stones.

## Dominantly well drained and moderately well drained soils of the uplands and outwash plains

These nearly level to gently undulating soils are on uplands. They make up about 40 percent of the county. The major soils of this group are Verhalen, Reakor, Hoban, Reeves, Holloman, Orla, and Saragosa soils. Most of these soils have a loamy surface layer and subsoil. Verhalen soils are clayey throughout. Orla, Holloman, Saragosa, Reeves, and Hoban soils have gypsiferous layers within a depth of 60 inches. They are mostly well drained and moderately well drained and are moderately permeable.

This group of map units includes most of the county's irrigated cropland. The city of Pecos is in this group. The rest is used as range. Saragosa, Orla, and Holloman soils are not suited to irrigation because of shallow rooting depth. Some of the Hoban, Reakor, Reeves, and Verhalen soils are irrigated. Major crops are cotton, alfalfa, barley, wheat, and grain sorghum. Small acreages of cantaloupes and onions are also grown. Native range grasses are blue grama, black grama, alkali sacaton, burrograss, and sideoats grama. Creosotebush, mesquite, and fourwing saltbush have encroached on some areas.

These soils have medium to low potential for urban uses. Moderate to high shrink-swell potential, depth to gypsiferous soil material, and corrosivity to uncoated steel are the major limitations. Dusty soil surfaces are the major limitation for recreational uses.

### 4. Verhalen-Reakor

*Deep, nearly level and gently sloping, moderately well drained and well drained, clayey and loamy soils; on outwash plains*

This map unit consists of soils that have 0 to 3 percent slopes. It makes up about 17 percent of the county. It is about 54 percent Verhalen soils, 15 percent Reakor soils, and 31 percent other soils.

The nearly level Verhalen soils are on outwash plains. Slopes are 0 to 1 percent. Typically, Verhalen soils have a surface layer of grayish brown, calcareous clay about 10 inches thick. The next layer, to a depth of 43 inches, is brown, calcareous clay. The underlying layer, to a depth of 60 inches, is pink, calcareous clay that has common soft masses and concretions of calcium carbonate.

The nearly level to gently sloping Reakor soils are on outwash plains. Slopes are 0 to 3 percent. Typically, Reakor soils have a surface layer of light brown, calcareous loam about 8 inches thick. The next layer, to a depth of 24 inches, is light brown, calcareous clay loam that has a few threads of calcium carbonate. The next layer, to a depth of 36 inches, is pink clay loam that has common concretions, soft masses, and threads of calcium carbonate. The underlying layer, to a depth of 60 inches, is pink, calcareous clay loam.

Other soils in this map unit are the deep, gravelly Canutio soils and the shallow, gravelly Delnorte and Upton soils. These nearly level to gently sloping soils are on uplands. Four deep, nearly level soils are also in this map unit. The clayey Dalby and Phantom soils are on uplands. The loamy Hodgins soils are on uplands and along narrow drainageways. The loamy Toyah soils are on flood plains and terraces of intermittent streams.

The soils in this map unit are used as irrigated cropland and rangeland. They have medium potential for irrigated crops. Management and the salinity of the irrigation water affect the yield. Cotton, alfalfa, barley, and grain sorghum are the main crops.

The potential for rangeland is high. Very low rainfall is a limiting factor, but most areas of Verhalen soils receive runoff from adjacent soils at higher elevations.

The soils in this map unit have low potential for most urban and recreational uses. They are corrosive to uncoated steel and have moderate to high shrink-swell potential. Some of the soils have very slow permeability and a clay surface texture. The soils of this unit are subject to possible flooding during years of heavy rainfall. The potential for recreational uses is low because of the dusty soil surface.

**5. Hoban-Reeves-Reakor**

*Deep and moderately deep, nearly level and gently sloping, well drained, loamy soils, on uplands.*

This map unit consists of soils that have 0 to 3 percent slopes. It makes up about 9 percent of the county. It is about 50 percent Hoban soils, 33 percent Reeves soils, 6 percent Reakor soils, and 11 percent other soils.

The nearly level Hoban soils are on uplands. Slopes are 0 to 2 percent. Typically, Hoban soils have a surface layer about 18 inches thick of silty clay loam that is light brown in the upper part and brown in the lower part. From a depth of 18 to 60 inches is pink silty clay loam that has 40 to 50 percent calcium carbonate and gypsum in the lower part. These soils are calcareous and moderately alkaline throughout.

The nearly level Reeves soils are on uplands. Slopes are 0 to 2 percent. Typically, Reeves soils have a surface layer of pale brown clay loam about 11 inches thick. The next layer, to a depth of 33 inches, is light yellowish brown clay loam. The underlying layer, to a depth of 60 inches, is very pale brown silty clay loam that has about 50 percent by volume gypsum and calcium carbonate concretions and masses. These soils are calcareous and moderately alkaline throughout.

The nearly level to gently sloping Reakor soils are on uplands. Slopes are 0 to 3 percent. Typically, Reakor soils have a surface layer of light brown, calcareous loam about 8 inches thick. The next layer, to a depth of 24 inches, is light brown, calcareous clay loam that has a few threads of calcium carbonate. The layer below, to a depth of 36 inches, is pink clay loam with common concretions, soft masses, and threads of calcium carbonate. The underlying layer, to a depth to 60 inches, is pink, calcareous clay loam. These soils are moderately alkaline throughout.

Several other soils are in this map unit. The clayey Dalby soils and loamy Hodgins soils are deep, nearly level soils in the lower areas. The shallow, very gravelly Delnorte soils; deep, very gravelly Nickel soils; and shallow, gravelly Upton soils are gently sloping soils on outwash ridges. The shallow, loamy Holloman soils; deep, loamy Monahans soils; and shallow, saline Orla soils are nearly level to gently sloping soils on areas near salt lakes or gypsum outcrops.

The soils of this map unit are used as irrigated crop-land and rangeland.

The potential for growing irrigated crops is high but is limited by the salinity of the irrigation water and the degree of management. Cotton, alfalfa, barley, wheat, and grain sorghum are the main crops. The potential for rangeland is medium because of very low rainfall.

The potential for most urban uses is medium because of corrosivity to uncoated steel and the shrink-swell potential. Some areas are subject to possible flooding during periods of abnormally heavy rainfall. The potential for recreational uses is medium because of the dusty soil surface.

### 6. Holloman-Reeves

*Very shallow to moderately deep, nearly level to gently undulating, well drained, loamy soils; on uplands*

This map unit consists of soils that have 0 to 5 per-cent slopes. It makes up about 9 percent of the county. It is about 65 percent Holloman soils, 15 percent Reeves soils, and 20 percent other soils.

Holloman soils are on uplands. Slopes range from 0 to 5 percent. Typically, Holloman soils have a surface layer of brown calcareous loam about 6 inches thick. The substratum is pink, calcareous, gypsiferous earth.

The nearly level to gently sloping Reeves soils are on uplands. Slopes are 0 to 2 percent. Typically, Reeves soils have a surface layer of pale brown clay loam about 11 inches thick. The next layer, to a depth of 33 inches, is light yellowish brown clay loam. The underlying layer, to a depth of 60 inches, is very pale brown silty clay loam that has about 50 percent by volume gypsum and calcium carbonate concretions and masses. These soils are calcareous and moderately alkaline throughout.

Several other soils are in this map unit. The shallow Delnorte and Lazier soils and the deep Nickel soils are very gravelly, undulating to rolling soils on hills. The deep, loamy, nearly level to gently sloping Hoban and Reakor soils are on uplands. The deep, loamy Hodgins soils are in narrow drainageways. The shallow, loamy Orla soils are on uplands near small salt lakes.

The soils of this map unit generally have low potential for irrigated cropland. However, if suitable irrigation water is available, some of the soils have medium potential.

The soils of this map unit are used as rangeland. The potential for rangeland is medium. Very low rainfall and shallow rooting depth in some soils limit forage production.

The soils of this map unit have low potential for most urban uses because of depth to gypsum, seepage, and corrosivity to uncoated steel and concrete. The potential for recreational use is medium because of the dusty soil surface.

### 7. Orla-Saragosa

*Shallow, nearly level and gently sloping, well drained and poorly drained, saline, loamy soils; on uplands*

This map unit consists of soils that have 0 to 3 per-cent slopes. It makes up about 5 percent of the county. It is about 61 percent Orla soils, 9 percent Saragosa soils, and 30 percent other soils.

The nearly level and gently sloping Orla soils have slopes of 0 to 3 percent. Typically, Orla soils have a surface layer of saline, moderately alkaline, pale brown clay loam about 5 inches thick. The substratum is very pale brown gypsiferous earth that extends to a depth of more than 60 inches.

The nearly level Saragosa soils are in depressional areas. Slopes range from 0 to 1 percent. Typically, Saragosa soils have an extremely saline, calcareous, brown clay loam surface layer about 4 inches thick. This layer rests abruptly on extremely saline, white, calcareous gypsiferous material that is soft in the upper part and weakly cemented in the lower part. This underlying layer ex-tends to a depth of more than 60 inches.

Other soils in this map unit are the deep, loamy, nearly level Balmorhea soils in depressional areas; the loamy, nearly level, deep Hoban soils and moderately deep Reeves soils on uplands; and the shallow, loamy, nearly level to gently sloping Holloman soils on uplands.

The soils of this map unit are used as rangeland, irrigated cropland, and urban land. The city of Pecos is in an area of this map unit.

These soils have low potential for irrigated cropland because of the presence of excess salt, shallow rooting depth, and the possibility of flooding. The main crops are cotton, alfalfa, and barley. in some of the soils, a seasonal, very strongly saline high water table occurs at a depth of 2 to 4 feet sometime during the fall, winter, or spring. The potential for rangeland is low because of soil salinity and very low rainfall.

These soils have medium potential for most urban uses. Moderate shrink-swell potential, seepage, and corrosivity to uncoated steel and concrete are limiting features. Some areas may flood during abnormally heavy rainfall. The potential for recreational uses is low because of the dusty soil surface.

## Well drained to somewhat poorly drained soils of the flood plains

These nearly level soils are on flood plains. They make up about 5 percent of the county. The major soils are Toyah, Bigetty, Balmorhea, Pecos, Arno, and Patrole soils. These soils have a loamy to clayey profile. Arno and Pecos soils are clayey and have deep cracks which water enters rapidly when the soil is dry. When the soil is wet, the cracks are sealed and water enters very slowly. The Balmorhea, Bigetty, Patrole, and Toyah soils are deep and loamy. The soils in these map units are well drained to somewhat poorly drained. Some of the soils are saline.

The soils of this map unit are used as rangeland and irrigated cropland. The soils along the Pecos River are moderately saline to extremely saline. The soils along Toyah Creek are slightly saline to moderately saline. A few areas near Toyah Lake are extremely saline. Cotton, alfalfa, barley, wheat, and grain sorghum are the major crops. Native range grasses are alkali sacaton, twoflower trichloris, vine-mesquite, cane bluestem, and sideoats grama. Fourwing saltbush, mesquite, and tamarisk (salt cedar) are the major woody plants.

The major limitation for urban uses is the possibility of flooding. Most areas are protected from frequent and occasional flooding, but will flood during abnormally heavy rains. These soils are highly corrosive to uncoated steel. The clayey soils have a high shrink-swell potential. The possibility of flooding and the dusty soil surface are limitations for recreational uses.

#### 8. Arno-Pecos-Patrole

*Deep, nearly level, moderately well drained, saline, loamy and clayey soils; on flood plains*

This map unit consists of soils that have 0 to 1 percent slopes. It makes up about 3 percent of the county. It is about 26 percent Arno soils, 23 percent Pecos soils, 21 percent Patrole soils, and 30 percent other soils.

Typically, Arno soils have a surface layer of saline, light brown silty clay about 11 inches thick. The next layer, to a depth of 41 inches, is saline, reddish brown clay. The underlying layer, to a depth of 60 inches, is saline, light gray silty clay loam.

Typically, Pecos soils have a surface layer of saline, grayish brown silty clay about 18 inches thick. The underlying layer, to a depth of 60 inches, is saline clay that is light gray in the upper part and light brownish gray in the lower part.

Typically, Patrole soils have a surface layer of saline, grayish brown silt loam about 7 inches thick. The next layer, to a depth of 32 inches, is saline, light brown silt loam that grades to very fine sandy loam in the lower part. This layer rests abruptly on moderately saline to strongly saline, reddish gray clay that extends to a depth of about 45 inches. The underlying layer, to a depth of 60 inches, is saline, pink loam.

Other soils in this unit are the deep, saline, loamy Gila and Toyah soils.

The soils of this map unit are used as rangeland and irrigated cropland, pastureland, and hayland.

The potential for growing cultivated crops is low because of the presence of excess salts and the lack of a dependable supply of good quality irrigation water. Very slow permeability is also a limiting feature for Arno and Pecos soils. Alfalfa, cotton, barley, and bermudagrass are the main irrigated crops. Annual rainfall is too low for nonirrigated cropland.

The potential for growing native range plants is medium because of soil salinity and low rainfall. The construction of several dams on the river above the area has reduced the frequency of flooding. These soils are now rarely flooded, and the yield of native range plants is lower.

The potential for most urban uses is low because of the possibility of flooding. Other limiting features are corrosivity to uncoated steel and piping. Arno and Pecos soils have high shrink-swell potential. The potential for recreational uses is low because of the possibility of flooding and the dusty soil surface.

### 9. Toyah-Bigetty-Balmorhea

*Deep, nearly level, well drained and somewhat poorly drained, loamy soils; on flood plains*

This map unit consists of soils that have 0 to 1 percent slopes. It makes up about 2 percent of the county. It is about 39 percent Toyah soils, 22 percent Bigetty soils, 22 percent Balmorhea soils, and 17 percent other soils.

The nearly level Toyah soils are on flood plains. Slopes are 0 to 1 percent. Typically, Toyah soils have a surface layer of dark grayish brown clay loam about 16 inches thick. The subsoil, to a depth of more than 60 inches, is light gray sandy clay loam with a few strata of clay loam. These soils are calcareous and moderately alkaline throughout. Areas of Toyah soils near salt lakes are saline.

The nearly level Bigetty soils are on flood plains. Slopes are 0 to 1 percent. Typically, Bigetty soils have a surface layer of neutral or mildly alkaline, brown loam about 15 inches thick. The next layer, to a depth of 35 inches, is moderately alkaline, grayish brown clay loam. These soils are typically calcareous throughout except in the upper few inches.

The nearly level Balmorhea soils are on flood plains and in depressional areas that were formerly spring-fed marshes. Slopes are 0 to 1 percent. Typically, Balmorhea soils have a surface layer of very dark gray silty clay loam about 18 inches thick. The next layer, to a depth of 28 inches, is dark gray silty clay loam. From 28 to 34 inches is a layer of very dark gray silty clay. The next layer, to a depth of 54 inches, is clay loam that is gray in the upper part and light brownish gray in the lower part. The underlying layer, to a depth of 60 inches, is pale brown clay loam. These soils are moderately alkaline and calcareous throughout.

Other soils in the map unit are the shallow, gypsiferous Holloman and Orla soils on small oval and rectangular "islands" on flood plains and terraces near the salt lakes; the deep, gravelly, nearly level Rockhouse soils on flood plains nearest the hills and mountains; and the deep, clayey, nearly level Verhalen soils that are mainly on outwash plains, and sometimes in flood plains.

The soils of this map unit are used as rangeland and irrigated cropland, pastureland, and hayland. Most of the town of Balmorhea is in this map unit.

The potential for growing irrigated crops is high except where the soils are subject to frequent flooding or are strongly saline. Cotton, alfalfa, barley, and grain sorghum are the main irrigated crops. Annual rainfall is too low for nonirrigated cropland.

The potential for growing native range plants is high. Low rainfall is the most limiting factor; however, these soils receive runoff water from adjacent higher soils and produce more forage than the soils of most other map units.

The potential for urban uses is low because of possible flooding and the shrink-swell potential. The potential for recreational uses is medium because of the dusty soil surface and possible flooding.

## Broad land use considerations

The soils in the survey area vary widely in their potential for major land uses. Table 4 shows the extent of the map units shown on the general soil map. It lists the potential of each, in relation to that of the other map units, for major land uses and shows soil properties that limit use. Soil potential ratings are based on the practices commonly used in the survey area to overcome soil limitations. These ratings reflect the ease of overcoming the limitations. They also reflect the problems that will persist even if such practices are used.

Each map unit is rated for irrigated farm crops, irrigated specialty crops, range, urban uses, and recreation areas. Irrigated farm crops are those grown extensively in the survey area; these are cotton, grain sorghum, wheat, barley, and alfalfa. Irrigated specialty crops are vegetables, fruits, pecans, and nursery crops, which are grown on limited acreage and generally require intensive management (fig. 1). Range refers to land in native range plants. Urban uses are farmsteads and residential, commercial, and industrial developments. Recreation areas are paths and trails, picnic areas, camp areas, and playgrounds.

***Figure 1.*—A specialty crop of irrigated cantaloupes on Reeves clay loam, 0 to 1 percent slopes.**

In general, the kind of soil, low rainfall, quantity and quality of irrigation water, soil salinity, and the high cost of producing irrigated crops are the important factors that influence land use in Reeves County.

Presently, about 89 percent of the county is used as rangeland and about 11 percent is used as irrigated cropland and pastureland. Less than 1 percent is developed land. About 19 percent of the county has high potential for range, 32 percent has medium potential, and 49 percent has low potential. About 21 percent of the county has high potential for irrigated farm crops, 27 percent has medium potential, and 52 percent has low potential. About 37 percent of the range is suitable for irrigated cropland if water is available.

As the cost of producing irrigated crops has increased, there has been a decrease in the number of acres used for irrigated cropland and an increase in the number of acres of idle irrigated cropland. There has been a slight increase in the number of acres used for urban development and recreation.

In general, the soils of the Verhalen-Reakor, Hoban-Reeves-Reakor, and Toyah-Bigetty-Balmorhea map units have medium to high potential for irrigated farm crops. Most of the areas of irrigated cropland are in these map units. The soils in these map units are deep, loamy or clayey soils that are well suited to irrigated cropland. The major problem is the salinity of the irrigation water, which has an electrical conductivity ranging from 2 to 6 millimhos per centimeter, with some as high as 8 millimhos per centimeter. These soils require good quality irrigation water and practices such as leaching, timely application, and proper lengths of irrigation runs. In addition, they require such soil management practices as leaving residue on the surface when crops are not being grown, timely and limited tillage, rotation of crops, and fertilization.

The soils of the Hoban-Reeves-Reakor, Holloman-Reeves, and Arno-Pecos-Patrole map units have medium potential for range because of low rainfall.

In most map units, shrink-swell potential, depth to rock, and possible flooding are major limitations for urban uses. None of the soils in these map units has high potential for recreational uses.

The potential of soils of the map units not mentioned is low for most uses. Slope, soil salinity, depth to rock or cemented caliche, small stones, and corrosivity are the most limiting features.

The general soil information in this section and the more detailed information in the following sections can be used as a guide in planning orderly growth and development of the county. This information is especially helpful in determining which lands to allocate to each use.

## Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Toyah loam is one of several phases in the Toyah series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

*A soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Canutio-Delnorte complex, 1 to 3 percent slopes, is an example.

*A soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Gila-Patrole association is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Hodgins soils, frequently flooded, is an undifferentiated group in this survey area. It is made up of Hodgins soils with variable textures of the surface layer.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 5 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

**1—Arno clay, saline.** This deep, nearly level soil is on flood plains. Slopes are less than 1 percent. Soil areas are irregular to rectangular in shape and range from 6 to 200 acres.

Typically, the surface layer is moderately saline, light brown clay about 16 inches thick. The underlying layer to a depth of more than 60 inches is moderately saline, pinkish gray clay. This soil is calcareous and moderately alkaline throughout.

This soil is moderately well drained. It is rarely flooded. Runoff is slow to ponded. Permeability is very slow. Available water capacity is low. The hazard of water erosion is slight and the hazard of soil blowing is moderate. Leaching of salts is very difficult. Because of the slow internal drainage, this soil generally is not suitable for cultivation. A few areas are being cultivated where irrigation water is available so that the soil can be leached.

Included with this soil in mapping are small areas of Pecos clay and Patrole silt loam. Also included are areas of a soil similar to Arno soils that has a clay loam subsoil. The included soils make up less than 10 percent of each mapped area.

This Arno soil has medium potential for growing native range plants. Very low rainfall and soil salinity are limiting features. Salt tolerant plants such as alkali sacaton, fourwing saltbush, big sacaton, and twoflower trichloris are the major vegetation of this soil. The potential for wildlife habitat is low.

This soil has low potential for urban and recreational uses because of rare flooding, high shrink-swell potential, and corrosivity to uncoated steel.

This Arno soil is in capability subclass IVs, irrigated, and VIIs, nonirrigated, and in the Salty Bottomland range site.

**2—Arno-Pecos-Patrole association.** The soils in this association are deep, nearly level soils on flood plains. Slopes are less than 1 percent. Soil areas are irregular in shape and range from 150 to several thousand acres.

Arno soils make up 20 to 60 percent of each mapped area, with an average of about 40 percent. Pecos soils make up 20 to 45 percent, Patrole soils make up 20 to 30 percent, and other soils make up less than 25 per-cent of each mapped area. All of these soils are on similar positions in the landscape. These soils are so similar in use and management that mapping them separately is not justified.

Typically, Arno soils in this association have a surface layer of saline, light brown silty clay about 11 inches thick. The underlying layer to a depth of 60 inches is saline, reddish brown clay in the upper part and saline, light gray silty clay loam in the lower part.

Typically, Pecos soils have a brown, saline surface layer about 28 inches thick that is silty clay in the upper 8 inches and clay in the lower part. The underlying layer to a depth of 60 inches is saline clay that has reddish brown mottles and is pinkish gray in the upper 5 inches and reddish brown in the lower 27 inches.

Typically, Patrole soils have a surface layer of saline, grayish brown silt loam about 7 inches thick. From 7 to 32 inches is saline, light brown silt loam that grades to very fine sandy loam in the lower part. This layer rests abruptly on very hard, saline, reddish gray clay that extends to a depth of about 45 inches. The underlying layer to a depth of 60 inches is saline, pink loam.

Arno, Pecos, and Patrole soils are calcareous and moderately alkaline throughout.

The soils in this association are moderately well drained. They are rarely flooded. Surface runoff is slow. Permeability is moderately slow to very slow. Available water capacity is low to moderate depending on the soil salinity. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are small areas of Toyah and Gila soils.

This association is used as rangeland. The potential for growing range plants is medium because of very low rainfall, very slow permeability, and soil salinity. Native vegetation includes alkali sacaton, fourwing saltbush, pickleweed, and mesquite. The potential for wildlife habitat is low.

The potential for urban and recreational uses is low because of corrosivity to uncoated steel, rare flooding, high shrink-swell potential, and clayey soil texture.

This association is in capability subclass VIIs, nonirrigated, and in the Salty Bottomland range site.

**3—Balmorhea silty clay loam.** This deep, nearly level soil is on flood plains that were formerly spring-fed marshes. Slopes are 0 to 1 percent. The surface is plane to concave. Soil areas are somewhat rectangular and range from 15 to 1,000 acres.

Typically, the surface layer is very dark gray silty clay loam about 18 inches thick. The next layer, to a depth of 28 inches, is dark gray silty clay loam. Between a depth of 28 to 34 inches is a layer of very dark gray silty clay. The underlying layer, to a depth of 54 inches, is clay loam that is gray in the upper part and light brownish gray in the lower part. Below that to a depth of 60 inches is pale brown clay loam. This soil is moderately alkaline and calcareous throughout.

This Balmorhea soil is somewhat poorly drained. It is rarely flooded. Runoff is slow. Permeability is moderately slow and available water capacity is high. This soil has moderate amounts of organic matter. The rooting zone is deep. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Verhalen and Toyah soils and some soils similar to Balmorhea soils that have a lighter colored surface layer. These soils make up less than 15 percent of each mapped area.

This Balmorhea soil is used as irrigated cropland, pastureland, and hayland. The major crops are cotton, barley, and alfalfa. The town of Balmorhea is in this map unit.

This soil has high potential for growing irrigated cotton, alfalfa, barley, and perennial pasture grasses. It is not suited to nonirrigated farming because of tilth and soil salinity. A well designed irrigation system and proper application of irrigation water are needed. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Residue also helps maintain soil productivity and reduces the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section, "Use and management of the soils" for more information on these and other management concerns.

Where it is used as native rangeland, this soil has potential to grow alkali sacaton, fourwing saltbush, two-flower trichloris, and other salt tolerant plants. However, because rainfall is low and the natural flow of runoff water onto the soil has been intercepted by road and irrigation ditches, a method of distributing water over the site is needed. Soil salinity generally increases after irrigation ceases. The potential for wildlife habitat is medium.

The potential for urban and recreational uses is low, because the soil is subject to rare flooding.

This Balmorhea soil is in capability subclass IIIs, irrigated, and VIs, nonirrigated, and in the Draw range site.

**4-Balmorhea association, saline.** The soils in this association are deep, nearly level soils on flood plains that were formerly spring-fed marshes. Slopes range from 0 to 2 percent, but are mostly less than 1 percent. The surface is plane to concave. Most soil areas are rectangular and range from 50 to 2,000 acres.

Balmorhea soils make up 60 to 75 percent of each mapped area and other soils make up 25 to 40 percent. These soils are so similar in use and management that mapping them separately is not justified.

Balmorhea soils have a surface layer of clay, silty clay, silty clay loam, or clay loam. Typically, they have a surface layer of moderately saline, dark grayish brown silty clay loam about 25 inches thick. The next layer, to a depth of 53 inches, is strongly saline, dark gray silty clay loam. The underlying layer to a depth of 60 inches is strongly saline, gray clay loam. These soils are calcareous and moderately alkaline throughout.

These soils are somewhat poorly drained. They are rarely flooded. Runoff is slow. Permeability is moderately slow, and available water capacity ranges from low to high depending on the degree of soil salinity. The rooting zone is deep. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are areas of Orla, Verhalen, Reeves, Holloman, and Hoban soils. These soils are on slightly higher positions in the landscape than the Balmorhea soils.

The soils of this association are used as rangeland. They are not suited to nonirrigated cropland, pasture-land, or hayland because of soil salinity and very low rainfall.

The potential for growing irrigated crops is low. Some areas may be suitable, but these areas should be investigated as to their high water table, salinity, and drainage.

The potential for growing native range plants is medium. Very low rainfall and rare flooding are limiting factors, but yields of highly salt tolerant plants are good during favorable years. The potential for wildlife habitat is low.

The potential for urban and recreational uses is low because of rare flooding.

These soils are in capability subclass VIs, nonirrigated, and IVs, irrigated, and in the Salty Bottomland range site.

**5—Bigetty association.** The soils in this association are deep, nearly level soils on flood plains of draws. Slopes are less than 1 percent. Most areas have a plane surface. A few areas have a concave surface. Soil areas are generally oblong to long and narrow and range from 70 to 1,500 acres.

Bigetty soils make up 75 to 90 percent of each mapped area, and other soils make up 10 to 25 percent. These soils are so similar in use and management that mapping them separately is not justified.

Bigetty soils have a surface layer of loam, silty clay loam, or clay loam. Typically, they have a surface layer of neutral, brown clay loam about 28 inches thick. The underlying layer to a depth of 60 inches is brown, moderately alkaline, calcareous silt loam.

These soils are well drained. They are rarely flooded. Runoff is slow to medium. Permeability is moderately slow. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are areas of Toyah and Rockhouse soils and a soil similar to Bigetty soils that has subsurface horizons of fine sandy loam. Areas of riverwash in stream channels are also included.

The soils of this association are used as rangeland. Where protected from flooding, Bigetty soils are suited to irrigated cropland if good quality water is available. These soils are not suited to nonirrigated farming because of very low rainfall. The potential for growing native range plants is high because runoff is received from higher adjacent areas. Native vegetation is sideoats grama, cane bluestem, and vine-mesquite. The potential for rangeland wildlife habitat is medium.

The soils in this association have low potential for most urban and recreational uses because of rare flooding.

These soils are in capability subclass VIIc, nonirrigated, and in the Draw range site.

**6—Bigetty-Rockhouse association.** The soils in this association are deep, nearly level soils on flood plains of draws. Slopes are less than 1 percent. Soil areas are mainly oblong to long and narrow and range from 500 to 1,500 acres.

Bigetty soils make up about 70 percent of each mapped area, Rockhouse soils make up about 20 percent, and other soils make up less than 10 percent. Bigetty soils are long, narrow, irregularly-shaped areas in the middle and on outer edges of flood plains. The surface is mainly plane, with a few concave areas. Rock-house soils are in channels of draws and in scattered old channel beds on flood plains. The surface of the Rock-house soils is mainly plane, with a few concave areas.

These soils are so similar in use and management that mapping them separately is not justified.

Typically, Bigetty soils have a surface layer of neutral or mildly alkaline, brown loam about 15 inches thick. The next layer, to a depth of 35 inches, is moderately alkaline, grayish brown clay loam. The underlying layer to a depth of 60 inches is moderately alkaline brown clay loam. These soils are typically calcareous except in the upper few inches.

Bigetty soils are well drained. They are rarely flooded. Runoff is medium to slow and permeability is moderately slow. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Typically, Rockhouse soils have a surface layer of neutral loam about 15 inches thick that is brown in the upper pail and grayish brown in the lower part. The next layer to a depth of 60 inches is neutral, brown, very cobbly loamy sand.

Rockhouse soils are well drained. They are flooded 2 years out of 3. Runoff is slow and permeability is rapid. Available water capacity is low. The hazard of water erosion and soil blowing is slight.

Other soils of this association are areas of soils similar to Bigetty soils except that they have a fine sandy loam subsurface horizon. Areas of riverwash in the stream channels are also included.

Areas of this association are used as rangeland. Protected from flooding, Bigetty soils are suited to irrigated cropland if good quality water is available. Rockhouse soils are not suited to irrigated cropland because of low available water capacity and cobbles, stones, and gravel. The soils of this association are not suited to nonirrigated farming because of very low rainfall. The potential for growing native range plants is high because runoff water is received from higher adjacent areas. Native vegetation is sideoats grama, cane bluestem, and vine-mesquite. The potential for rangeland wildlife habitat is medium.

The soils of this association have low potential for most urban and recreational uses because of rare or frequent flooding.

The capability subclass is VIIc, nonirrigated for Bigetty soils, and VIs, nonirrigated for Rockhouse soils. Both soils are in the Draw range site.

**7—Boracho-Espy association, undulating.** The soils in this association are shallow, very gravelly and gravelly, loamy soils on fans and ridges of valleys and outwash plains. Slopes range from 1 to 8 percent. Soil areas are oblong to irregular in shape and range from 16 to 1,300 acres.

Boracho soils make up 40 to 70 percent of each mapped area, and Espy soils make up 30 to 40 percent. Other soils make up less than 30 percent of each mapped area.

Boracho soils generally are long, narrow, or irregular oblong areas on the lower part of fans and ridges. The surface of Boracho soils is mainly concave, with some areas of convex or plane surface. Espy soils typically are long, narrow, or irregular oblong areas on the upper part of fans and ridges. The surface of Espy soils is mainly convex, with some areas of plane or concave surfaces. These soils are so similar in use and management that mapping them separately is not justified.

Typically Boracho soils have a surface layer of moderately alkaline, calcareous, brown very gravelly loam about 12 inches thick. The next layer, to a depth of 20 inches, is very pale brown caliche that is indurated in the upper part and weakly cemented in the lower part. The underlying layer to a depth of 60 inches is very pale brown very gravelly loam.

Typically, Espy soils have a surface layer of moderately alkaline, calcareous, grayish brown gravelly loam about 7 inches thick. The next layer, to a depth of 17 inches, is moderately alkaline, calcareous, pale brown gravelly loam. From 17 to 24 inches is pinkish white indurated to strongly cemented caliche. The underlying layer to a depth of 60 inches is very pale brown very gravelly loam.

These soils are well drained. Runoff is medium and permeability is moderate. Available water capacity is very low. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Other soils of this association are small areas of Hodgins, Reakor, Ector, Upton, Sanderson, and Rockhouse soils. Hodgins and Reakor soils are in narrow valleys. Ector and Upton soils are irregular oblong areas on the lower part of ridges. Sanderson and Rockhouse soils are in long, narrow valleys.

The soils in this association are not suitable for cultivation because of shallow rooting depth, susceptibility to water erosion, slope, and very low available water capacity. These soils are used as rangeland. The potential for growing native range plants is medium. Low rainfall, very low available water capacity, and shallow rooting depth limit forage production. The potential for wildlife habitat is low.

The soils in this association have medium potential for most urban uses. Depth to indurated caliche and corrosivity to uncoated steel are limiting features. The potential for recreational uses is medium because of a gravelly or dusty soil surface.

These soils are in capability subclass VIs, nonirrigated, and in the Shallow range site.

**8—Brewster association, hilly.** The soils in this association are very shallow and shallow soils on uplands. Slopes range from 10 to 30 percent, but the average is about 15 percent. Soil areas are oval to irregular in shape and range from 10 to several thousand acres.

Each mapped area is 60 to 80 percent Brewster soils, 5 to 15 percent Rock outcrop, 5 to 15 percent Limpia soils, and up to 30 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The gravelly or very gravelly Brewster soils have a surface layer of loam or clay loam. Typically, they have a surface layer of mildly alkaline, calcareous, dark grayish brown very gravelly loam about 6 inches thick. As much as 20 percent of the surface is covered with stones. The substratum is fractured igneous bedrock.

Brewster soils are well drained. Runoff is rapid and permeability is moderate. Available water capacity is very low. The hazard of water erosion is high and the hazard of soil blowing is slight.

Other soils of this association are areas of soils similar to Brewster soils that are deeper than 20 inches to bedrock; soils deeper than 40 inches to bedrock in narrow draws; areas of less sloping Brewster soils; and areas of Rockhouse soils.

The soils in this association are not suitable for cultivation because of slope, shallow rooting depth, coarse fragments, and susceptibility to water erosion. These soils are used as rangeland. The potential for growing native range plants is medium. Very low rainfall, rapid runoff, and very low available water capacity limit plant growth. However, because of the stones and Rock out-crop, rainwater soaks deeper into these soils and evaporation is less, allowing more forage production than on similar soils without rocks. The potential for wildlife habitat is medium.

The soils in this association have low potential for urban and recreational uses because of slope, depth to bedrock, and small and large stones.

These soils are in capability subclass VIIs, nonirrigated, and in the Igneous Hill and Mountain range site.

**9—Brewster-Rock outcrop association, steep.** The components in this association are on igneous hills and mountains. Slopes range from about 20 percent to almost vertical along the escarpments of igneous Rock outcrop. The mapped areas are irregular in shape and range from 300 to 1,000 acres.

Brewster soils make up 40 to 60 percent of each mapped area, Rock outcrop makes up 20 to 50 percent, and other soils make up as much as 25 percent. Brewster soils typically occur on the higher positions in the landscape. Rock outcrop consists of areas of vertical scarps and bare rock exposed throughout the area. These soils and Rock outcrop are so similar in use and management that mapping them separately is not justified.

Typically, Brewster soils have a surface layer of neutral, brown stony loam about 10 inches thick. As much as 20 percent of the surface is covered with stones. The surface layer rests abruptly on fractured igneous bed-rock.

Brewster soils are well drained. Runoff is rapid and permeability is moderate. Available water capacity is very low. The hazard of water erosion is severe and the hazard of soil blowing is slight.

Other soils of this association are areas of Limpia. Mitre, and Rockhouse soils and a soil similar to Brewster soils that is deeper than 20 inches to bedrock.

The soils in this association are not suitable for cultivation because of slope, very shallow to shallow rooting depth, coarse fragments, and susceptibility to water erosion. These soils are used as rangeland. The potential for growing native range plants is medium. Very low rainfall, rapid runoff, and very low available water capacity limit plant growth. However, because of the stones and Rock outcrop, rain water soaks deeper into these soils and evaporation is less, allowing more forage production than on similar soils without rocks. The potential for rangeland wildlife habitat is medium.

These soils have low potential for urban and recreational uses because of slope, depth to bedrock, Rock outcrop, and small and large stones.

Brewster soils are in capability subclass VIIs, nonirrigated, and in the Igneous Hill and Mountain range site. Rock outcrop is not classified.

**10—Canutio-Delnorte complex, 1 to 3 percent slopes.** The soils in this complex are deep, shallow, and very shallow, gently sloping soils on uplands. Their surface is generally convex but is plane on the top of the small ridges. These soils formed in gravelly alluvium that was deposited in or along old stream channels. Soil areas are 1 to 6 feet higher than the surrounding area and are generally oval, oblong, or long, narrow and irregular in shape and range from about 3 to 150 acres.

Canutio soils make up about 30 to 60 percent of each mapped area, Delnorte soils make up 30 to 50 percent, and other soils make up 5 to 20 percent. Canutio and Delnorte soils are on similar positions in the landscape. These soils are so intricately mixed that mapping them separately at the scale used is not practical.

Typically, Canutio soils have a surface layer of moderately alkaline, calcareous, light yellowish brown very gravelly sandy loam about 8 inches thick. The underlying layer is moderately alkaline, calcareous, very pale brown very gravelly sandy loam.

Canutio soils are well drained. Runoff is rapid and permeability is moderately rapid. Available water capacity is low. The hazards of water erosion and soil blowing are slight.

Typically, Delnorte soils have a surface layer of moderately alkaline, calcareous, pale brown gravelly loam about 5 inches thick. The next layer, to a depth of 12 inches, is very pale brown gravelly loam. From 12 to 32 inches is very pale brown, strongly cemented caliche. The underlying layer to a depth of 80 inches is light gray gravelly loam.

Delnorte soils are excessively drained. Runoff is rapid and permeability is moderate. Available water capacity is very low. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Included with these soils in mapping are areas of Limpia, Mitre, Reakor, and Nickel soils. These soils are at the base or lower edges of ridges and in low basins between ridges. Also included are areas of soils similar to Canutio soils that have a gravelly subsoil.

The soils in this map unit are not suitable for cultivation because of gravel, soil depth, and low available water capacity. These soils are used mainly as range-land, but small areas are in irrigated fields. The potential for growing native range plants is low. Low rainfall, rapid runoff, and low to very low available water capacity limit forage production. The potential for wildlife habitat is low.

The soils in this complex have low potential for most urban uses because of depth to cemented caliche, small stones, and seepage. The potential for recreational uses is low because of the surface gravel.

These soils are in capability subclass VIIs, nonirrigated, and in the Gravelly range site.

**11—Dalby clay.** This deep, nearly level soil is on terraces and valley fills. Slopes are less than 1 percent. The surface is plane to concave with slight gilgai microrelief. Soil areas are somewhat rectangular, oval, or irregular in shape and range from about 4 to 1,900 acres.

Typically, the surface layer is pinkish gray clay about 10 inches thick. The next layer, to a depth of 26 inches, is brown clay. The underlying layer to a depth of 60 inches is light brown silty clay in the upper part and pink silty clay loam in the lower part. This soil is moderately alkaline and calcareous throughout.

Dalby clay is well drained. It is rarely flooded. Runoff is very slow. Water enters rapidly when the soil is dry, but permeability is very slow when the soil is wet. Available water capacity is moderate. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Hoban, Hodgins, and Reakor soils. These soils are generally on the higher positions in the landscape. The included soils make up as much as 25 percent of each mapped area.

This soil is used as rangeland and irrigated cropland, hayland, and pastureland. Cotton, barley, and alfalfa are the major crops. The soil is not suited to nonirrigated farming because of very low rainfall. The potential for growing irrigated crops depends on the quantity and quality of the water used.

Major concerns of management are tilth and soil salinity. A well designed irrigation system and proper application of irrigation water are needed. Both surface and sprinkler irrigation systems can be used, but where the irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation may result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program that is based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

This Dalby soil has high potential for growing native plants. Low rainfall is a limiting factor, but most areas receive runoff from higher adjacent areas. Characteristic native range plants are tobosa, vine-mesquite, blue grama, and cane bluestem. The potential for rangeland wildlife habitat is medium.

This soil has low potential for urban and recreational uses because of corrosivity to uncoated steel, very high shrink-swell potential, very slow permeability, and a clayey surface. This soil is subject to flooding during abnormally heavy rainfall.

This soil is in capability subclass IIs, irrigated, and VIs, nonirrigated, and in the Clay Flat range site.

**12—Delnorte-Nickel association, rolling.** The soils in this association are very shallow, shallow, and deep soils on uplands. Slopes range from 5 to 12 percent. Soil areas are oblong, oval, or irregular in shape and range from 16 acres to several thousand acres.

Delnorte soils make up 50 to 70 percent of each mapped area and Nickel soils make up 10 to 30 percent. A few areas are dominantly Nickel soils. Other soils make up as much as 15 percent of each mapped area. Delnorte soils typically are on the crest and upper parts of slopes of hills and ridges. Nickel soils typically are on lower and middle parts of slopes of hills and ridges. These soils are so similar in use and management that mapping them separately is not justified.

Typically, Delnorte soils have a surface layer of moderately alkaline, calcareous, pale brown gravelly loam about 5 inches thick. The next layer, to a depth of 12 inches, is very pale brown very gravelly loam. From a depth of 12 to 32 inches is very pale brown, strongly cemented caliche. The underlying layer to a depth of 80 inches is light gray gravelly loam.

Typically, Nickel soils have a surface layer of pale brown very gravelly sandy loam about 10 inches thick. The underlying layer, to a depth of 70 inches, is pale brown very gravelly loam that has about 70 percent caliche fragments in the upper part and 40 percent caliche fragments and igneous gravel in the lower part.

The soils in this association are well drained. Runoff is medium or rapid. Permeability is moderate or moderately slow. Available water capacity is very low. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Other soils of this association are areas of Upton, Hodgins, Reakor, and Lozier soils, and a soil similar to Nickel soils that has less than 35 percent gravel and contains gypsum in the lower layers. The nearly level Upton soils generally are on the top of hills. Lozier soils and limestone Rock outcrop are on the sides of hills. Reakor and Hodgins soils are at the base of hills and in narrow drainageways. Some areas of this association have slopes of 2 to 5 percent.

The soils in this association are not suited to irrigated cropland because of very low available water capacity and high volume of gravel. These soils are used mainly as rangeland, but the potential for growing native range plants is low. Low rainfall, very low available water capacity, and lack of runoff from adjacent areas limit forage production. The potential for wildlife habitat is low.

The soils in this association have medium to low potential for most urban uses because of depth to caliche and corrosivity to uncoated steel. The potential for recreational uses is low because of surface gravel.

Delnorte soils are in capability subclass VIIs, nonirrigated. Nickel soils are in capability subclass VIIe, nonirrigated. Both soils are in the Gravelly range site.

**13—Ector association, hilly.** The soils in this association are shallow and very shallow soils on limestone hills. Slopes range from 10 to 30 percent. Soil areas are irregular in shape and range from about 200 to several thousand acres.

Ector soils make up about 60 to 70 percent of each mapped area, and other soils make up 30 to 40 percent. Rock outcrop makes up about 5 percent of the map unit. The Ector soils are on convex slopes of higher elevations. The other soils are dominantly on concave slopes of narrow valleys. These soils are so similar in use and management that mapping them separately is not justified.

The Ector soils have a surface layer, exclusive of coarse fragments, of silt loam, loam, or clay loam. Typically, the surface layer is calcareous, very gravelly loam about 9 inches thick and is grayish brown in the upper part and brown in the lower part. This layer is about 50 percent limestone fragments. The underlying layer is fractured limestone. As much as 20 percent of the surface is covered with stones.

These soils are well drained. Permeability is moderate. Runoff is rapid. Runoff is considerable during heavy rains. Available water capacity is very low. If the soils are not protected with a grass cover, the hazard of water erosion is moderate to severe. The hazard of soil blowing is slight.

Other soils of this association are Reakor, Upton, Sanderson, and Hodgins soils and areas of a soil similar to Ector soils that has limestone at a depth of 20 to 40 inches.

The soils in this association are not suited to cropland because of shallow root depth, very low available water capacity, and large amounts of gravel, cobbles, and stones. These soils are used as rangeland. The potential for growing native range plants is medium. Low rainfall, shallow rooting depth, and very low available water capacity limit forage production. The potential for rangeland wildlife habitat is medium.

The soils in this association have low potential for most urban uses because of slope and depth to bed-rock. The potential for recreational uses is low because of slope and small and large stones.

These soils are in capability subclass VIIs, nonirrigated, and in the Limestone Hill and Mountain range site.

**14—Gila fine sandy loam, saline.** This deep, nearly level soil is on flood plains. Slopes average about 0.5 percent. Soil areas are irregular in shape and range from 50 to several hundred acres.

Typically, this soil has a surface layer of light brownish gray fine sandy loam about 11 inches thick. The underlying layer to a depth of 60 inches is pale brown fine sandy loam with thin lenses of silt loam in the upper part and is brown silt loam in the lower part. This soil is saline, moderately alkaline, and calcareous throughout.

This Gila soil is well drained. It is rarely flooded. Runoff is slow. Permeability is moderate. Available water capacity is moderate because of soil salinity. The rooting zone is deep and easily penetrated by plant roots. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Pecos, Arno, Toyah, and Patrole soils. These included soils make up less than 20 percent of each mapped area.

Most of the soil in this map unit is or has been used as irrigated cropland and pastureland. Small areas are used as rangeland.

This soil has medium potential for growing irrigated cotton, alfalfa, barley, and perennial pasture grasses. It is not suitable for nonirrigated farming. Major concerns of management are tilth and soil salinity. A well designed irrigation system and proper application of irrigation water are needed. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation may result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

This soil has medium potential for growing native range plants. Its potential is limited because of low rainfall and rare overflow. Characteristic native range plants are alkali sacaton, fourwing saltbush, vine-mesquite, and giant sacaton. The potential for rangeland wildlife habitat is low.

This soil has low potential for most urban uses because of rare flooding and corrosivity to uncoated steel. The potential for recreational uses is medium because of the dusty soil surface.

This Gila soil is in capability subclass IIs, irrigated, and VIIs, nonirrigated, and in the Salty Bottomland range site.

**15—Gila-Patrole assoclation.** The soils in this association are deep, nearly level soils on flood plains. Slopes are less than 1 percent. Soil areas are irregular to elongated in shape and range from about 30 to 2,400 acres.

Gila soils make up 30 to 50 percent of each mapped area, and Patrols soils make up 20 to 50 percent (fig. 2). Other soils make up 5 to 20 percent of each mapped area. These soils are so similar in use and management that mapping them separately is not justified.

*Figure 2..*—**An area of Gila-Patrole association in the Salty Bottomland range site. These soils are on flood plains of the Pecos River.**

Typically, Gila soils have a surface layer of pale brown fine sandy loam about 11 inches thick. The substratum, to a depth of 25 inches, is pale brown fine sandy loam in the upper 10 inches and brown very fine sandy loam in the lower 4 inches. The underlying layer to a depth of 60 inches is pale brown loamy very fine sand in the upper part and pale brown very fine sandy loam in the lower part. These soils are saline, calcareous, and moderately alkaline throughout.

Gila soils are well drained. They are rarely flooded. Runoff is slow and permeability is moderate. Available water capacity is generally moderate, but depends on soil salinity. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Typically, Patrole soils have a surface layer of grayish brown silt loam about 7 inches thick. The substratum, to a depth of 32 inches, is light brown silt loam in the upper part and light brown very fine sandy loam in the lower part. This layer rests abruptly on reddish gray clay that extends to a depth of about 45 inches. The underlying layer to a depth of 60 inches is pink loam. These soils are saline, calcareous, and moderately alkaline through-out.

Patrole soils are moderately well drained. They are rarely flooded. Runoff is slow. Permeability is moderate above the clay layer and very slow in the clay layer. Available water capacity is low. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils in this association are small areas of Arno, Pecos, Toyah, and Bigetty soils.

All of the soils in this association are used as rangeland; however, they are suited to irrigated cropland. The potential for growing native range plants is medium. Soil salinity and low rainfall are limiting features. Native vegetation is salt tolerant plants such as alkali sacaton, big sacaton, twoflower trichloris, fourwing saltbush, vine-mesquite, and white tridens. The potential for rangeland wildlife habitat is low.

The soils in this association have low potential for most urban and recreational uses because they are subject to rare flooding.

These soils are in capability subclass VIIs, nonirrigated, and in the Salty Bottomland range site.

**16—Hoban silty clay loam, 0 to 1 percent slopes.** This deep, nearly level soil is on uplands. Slopes aver-age about 0.5 percent. The soil areas are irregular in shape and range from 10 to 2,500 acres.

Typically, the surface layer is silty clay loam about 18 inches thick that is light brown in the upper part and brown in the lower part. Between a depth of 18 to 60 inches is pink silty clay loam that is 40 to 50 percent calcium carbonate and gypsum masses. This soil is calcareous and moderately alkaline throughout.

This soil is well drained. Runoff is slow and permeability is moderate. Available water capacity is moderate. The soil surface tends to crust over when irrigated. The rooting zone is deep and is easily penetrated by plant roots. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Reeves, Holloman, Orla, Monahans, and Upton soils. These included soils make up less than 20 percent of each mapped area.

This Hoban soil is used as irrigated cropland. Cotton, alfalfa, barley, wheat, and grain sorghum are the major crops. Very low rainfall limits the success of nonirrigated farming.

Major concerns of management are tilth and soil salinity. The potential for growing irrigated crops depends on the quantity and salinity of the water used. A well de-signed irrigation system and proper application of irrigation water are needed. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation may result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

The potential for native rangeland is low. Very low rainfall and little runoff from higher adjacent areas, which has been reduced because of road and irrigation ditch construction, are limitations. The potential for wildlife habitat is medium where irrigated.

This soil has medium potential for most urban uses. Moderate shrink-swell potential, seepage, and corrosivity to uncoated steel are the major limitations. Low strength is a limitation for local roads and streets. Some areas are flooded during abnormally heavy rainfall. The potential for recreational uses is low because of the dusty soil surface.

This soil is in capability class I, irrigated, and subclass VIIc, nonirrigated, and in the Loamy range site.

**17—Hoban-Reeves-Holloman association, nearly level.** The soils in this association are deep, moderately deep, shallow, and very shallow, nearly level soils on uplands. Slopes are 0 to 3 percent. Areas are irregular in shape and range from 150 to several thousand acres.

Hoban soils make up 30 to 40 percent of each mapped area, Reeves soils make up 20 to 30 percent, and Holloman soils make up 5 to 40 percent. Other soils make up as much as 15 percent of each mapped area. These soils all are on similar positions in the landscape (fig. 3). The main difference between these soils is the depth to the gypsiferous layer. This depth, in many places, varies from deep to very shallow over a short distance. These soils are so similar in use and management that mapping them separately is not justified.

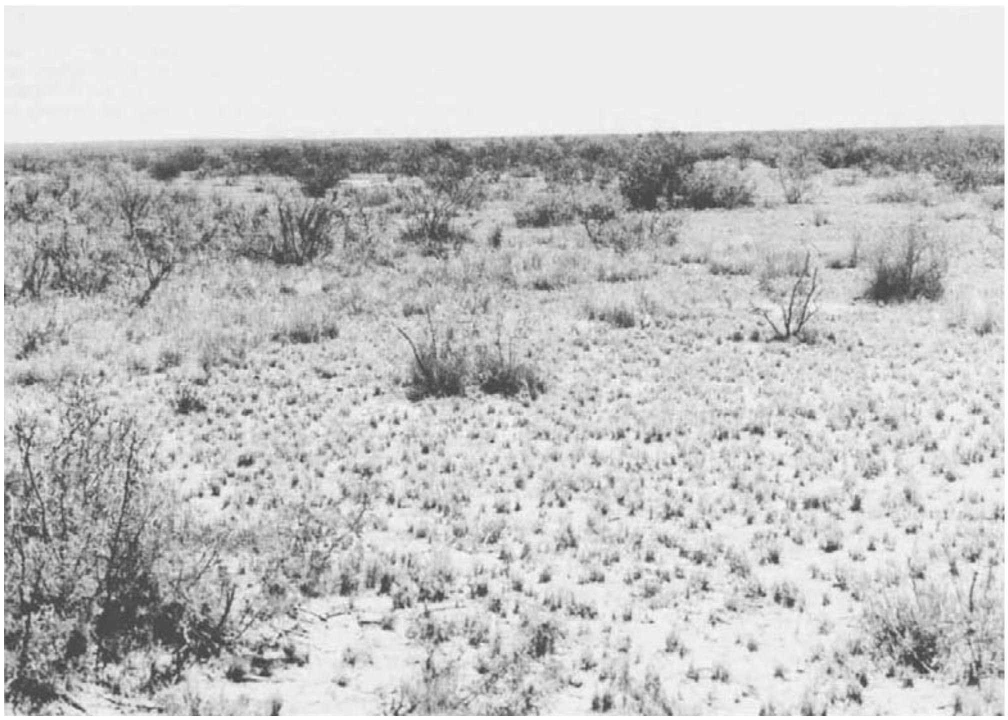

***Figure 3.*—An area of Hoban-Reeves-Holloman association, nearly level, in the Loamy range site.**

Typically, Hoban soils have a surface layer of pinkish gray clay loam about 8 inches thick. The next layer, to a depth of 36 inches, is pinkish gray clay loam that has about 5 percent by volume visible calcium carbonate in the lower part. From 36 to 45 inches is very pale brown clay loam containing about 15 percent by volume visible calcium carbonate. The underlying layer to a depth of 60 inches is brownish gypsiferous earth. These soils are calcareous and moderately alkaline throughout.

Hoban soils are well drained. Runoff is slow and permeability is moderate. Available water capacity is moderate. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Typically, Reeves soils have a surface layer about 6 inches thick. The next layer, to a depth of 36 inches, is light brown clay loam. This layer rests abruptly on pink, calcareous, gypsiferous earth extending to a depth of more than 60 inches. These soils are calcareous and moderately alkaline throughout.

Reeves soils are well drained. Runoff is medium and permeability is moderate. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Typically, Holloman soils have a surface layer of light brown loam about 15 inches thick. This layer rests abruptly on pinkish white, calcareous, gypsiferous earth extending to a depth of more than 60 inches.

Holloman soils are well drained. Runoff is medium and permeability is moderate. Available water capacity is very low. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are small areas of Reakor, Delnorte, and Hodgins soils. Delnorte and Reakor soils are on higher areas of the association and Hodgins soils are along narrow drainageways.

Most of these soils are used as rangeland, but they are suited to irrigated cropland if irrigation water of sufficient quantity and good quality is available. The potential for growing native range plants is medium because of very low rainfall. Characteristic plants are blue grama, black grama, and burrograss. The potential for wildlife habitat is low.

The soils in this association have medium potential for most urban uses. Hoban and Reeves soils have moderate shrink-swell potential and low strength. Low strength is a limitation for local roads and streets. Holloman soils are shallow over gypsum. All of the soils are corrosive to uncoated steel. The potential for recreational uses is low because of the dusty soil surface.

Hoban soils are in capability subclass VIIc, nonirrigated. Reeves and Holloman soils are in capability subclass VIIs, nonirrigated. All of these soils are in the Loamy range site.

**18—Hodgins silty clay loam, 0 to 1 percent slopes.** This deep, nearly level soil is on valleys and outwash plains in the irrigated areas of the county. Soil areas are irregular in shape and range from about 7 to 2,700 acres.

Typically, the surface layer is pale brown silty clay loam about 8 inches thick. The next layer, to a depth of 36 inches, is pale brown silty clay loam in the upper part and very pale brown silty clay in the lower part. The underlying layer to a depth of 60 inches is yellowish brown silty clay. This soil is calcareous and moderately alkaline throughout.

This soil is well drained. It is rarely flooded. Runoff is slow. Permeability is moderate. Available water capacity is high. This soil has a deep rooting zone easily penetrated by plant roots. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Hoban, Reeves, and Dalby soils. The Hoban and Reeves soils are on slightly higher elevations and the Dalby soils are on lower elevations. Also included are some areas of soils similar to Hodgins soils that have a dark surface layer and less carbonate in the subsoil. The included soils make up as much as 15 percent of each mapped area.

All of this soil is used as irrigated cropland. Major crops are cotton, alfalfa, grain sorghum, barley, and wheat (fig. 4). This Hodgins soil is well suited to irrigated pastureland. It is not suited to nonirrigated farming because of very low rainfall.

Major concerns of management are soil tilth and salinity. The potential for growing irrigated crops depends on the quantity and salinity of the water used. A well de-signed irrigation system and proper application of irrigation water are essential. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation may result in leaf burn.

Leaving residue on the surface when crops are not grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

*Figure 4.*—**Irrigated wheat on Hodgins silty clay loam, 0 to 1 percent slopes. A graded furrow system is used for irrigation.**

The potential for native rangeland is low. Very low rainfall and little runoff from higher adjacent areas, which has been reduced because of road and irrigation ditch construction, are limitations. The potential for wildlife habitat is medium.

This soil has medium potential for most urban uses. Rare flooding, moderate shrink-swell potential, seepage, and corrosivity to uncoated steel are limitations. Low strength is a limitation for local roads and streets. This soil has low potential for recreational uses because of the dusty soil surface.

This soil is in capability subclass IIs, irrigated, and VIw, nonirrigated, and in the Loamy range site.

**19—Hodgins soils, frequently flooded.** These deep, nearly level soils are on concave slopes along drainageways and draws. Slopes are 0 to 1 percent. Soil areas are long and narrow and range from 200 to 3,300 acres.

This map unit is 65 to 85 percent Hodgins soils and 15 to 35 percent other soils. The Hodgins soils in this map unit have a surface layer of clay loam, silty clay loam, silty clay, loam, or clay loam. These soils with varying textures do not occur in a regular pattern.

Typically, these soils have a surface layer of pale brown silty clay loam about 7 inches thick. From 7 to 60 inches is brown silty clay. These soils are calcareous and moderately alkaline throughout.

These soils are well drained. They are briefly flooded about 2 years out of 5. Runoff is slow and permeability is moderate. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils in this map unit are areas of Hoban, Orla, Reakor, and Toyah soils.

All of the soils in this map unit are used as rangeland. They are not suited to cropland because of frequent flooding. The potential for growing native range plants is high because of the extra water coming on the soil. The potential for wildlife habitat is medium.

The soils in this unit have low potential for urban and recreational uses because of frequent flooding.

These soils are in capability subclass VIw, nonirrigated, and in the Draw range site.

**20—Holloman-Reeves association, gently undulating.** The soils in this association are very shallow, shallow, and moderately deep soils on uplands. Slopes range from 1 to 5 percent. Soil areas are oblong, oval, or irregular in shape and range from 30 to several thousand acres.

Holloman soils make up 65 to 95 percent of each mapped area, Reeves soils make up as much as 35 percent, and other soils make up less than 15 percent. The average composition is about 75 percent Holloman soils, 15 percent Reeves soils, and 10 percent other soils. Holloman soils are on higher positions in the landscape, and Reeves soils are in lower areas (fig. 5). These soils are so similar in use and management that mapping them separately is not justified.

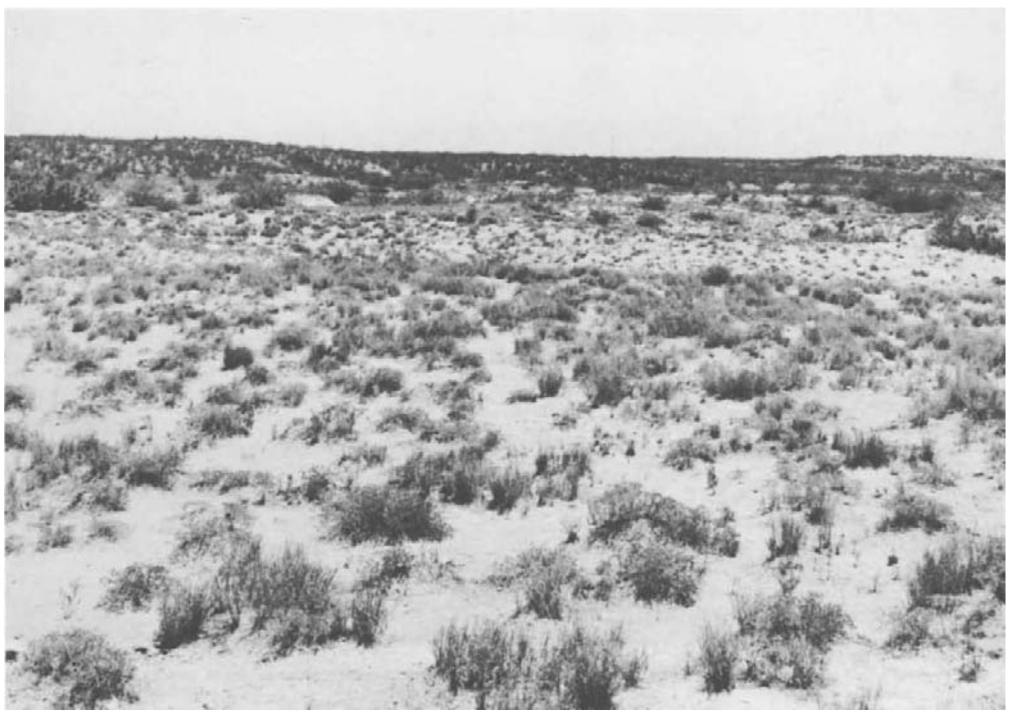

***Figure 5.—An*** **area of Holloman-Reeves association, gently undulating. Holloman soils, on higher elevations, are in the Gyp range site. Reeves soils, on lower elevations, are in the Loamy range site.**

Typically, Holloman soils have a surface layer of brown loam about 6 inches thick. This layer rests abruptly on calcareous, pink gypsiferous earth.

Holloman soils are well drained. Runoff is medium and permeability is moderate. Available water capacity is very low. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Typically, Reeves soils have a surface layer of brown clay loam about 7 inches thick. The next layer, to a depth of 28 inches, is brown silty clay loam. This layer rests abruptly on brown gypsiferous earth. These soils are calcareous and moderately alkaline throughout.

Reeves soils are well drained. Runoff is medium and permeability is moderate. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are small areas of Hoban, Nickel, Lazier, Hodgins, and Reakor soils.

The Holloman soils in this association are not suited to irrigated cropland because of very shallow depth to gypsiferous material. Reeves soils are suited to irrigated cropland where good quality water is available in sufficient quantity. Most of the soils in this association are used as rangeland. The potential for growing native range plants is low for Holloman soils and medium for Reeves soils. Very low rainfall, very shallow root depth, and very low available water capacity of the Holloman soils limit forage production. The potential for wildlife habitat is low.

The soils in this association have low potential for most urban uses. Depth to gypsum, seepage, and corrosivity to uncoated steel and concrete and moderate shrink-swell potential of Reeves soils are limitations. The potential for recreational uses is medium because of the dusty soil surface.

These soils are in capability subclass VIIs, nonirrigated. Holloman soils are in the Gyp range site and Reeves soils are in the Loamy range site.

**21—Limpia-Mitre association, gently sloping.** The deep and shallow, gently sloping soils in this association are on upland alluvial fans, terraces, and outwash plains. Slopes range from 0.5 to 3 percent, but average about 2 percent. Soil areas are oval, oblong, or irregular in shape and range from 8 to 2,000 acres.

Limpia soils make up 50 to 70 percent of each mapped area, and Mitre soils make up 30 to 40 percent (fig. 6). Other soils make up as much as 15 percent of each mapped area. The Limpia and Mitre soils are on similar positions in the landscape. These soils are so similar in use and management that mapping them separately is not justified.

***Figure 6.*—The foreground is an area of Limpia-Mitre association, gently sloping. Limpia and Mitre soils are in the Foothill Slope range site. Brewster soils are on the hills in the background.**

Typically, Limpia soils have a surface layer of neutral, brown very cobbly loam about 10 inches thick. The next layer, to a depth of 57 inches, is very cobbly clay that is neutral and reddish brown in the upper part and calcareous, moderately alkaline, and yellowish red in the lower part. The underlying layer is pink loam with about 50 percent by volume calcium carbonate concretions and soft masses.

Limpia soils are well drained. Runoff is medium and permeability is slow. Available water capacity is low. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Typically, Mitre soils have a surface layer of neutral, reddish brown very gravelly loam about 4 inches thick. The next layer, to a depth of 10 inches, is neutral, reddish brown very gravelly clay loam. This layer rests abruptly on pinkish white indurated caliche.

Mitre soils are well drained. Runoff is medium and permeability is moderate. Available water capacity is very low. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Other soils of this association are small areas of Rock-house and Verhalen soils. These soils are generally in narrow drainageways on the lower positions in the landscape. Also in this association are some areas of soils similar to Limpia soils that have a dark surface layer less than 20 inches thick.

The soils in this map unit are not suitable for cultivation because of gravel and cobbles, soil depth, and low available water capacity. These soils are used mainly as rangeland. The potential for growing native range plants is medium. Low rainfall, low to very low available water capacity, and lack of runoff from adjacent areas limit forage production. The potential for wildlife habitat is medium.

The soils in this association have low potential for most urban uses because of depth to caliche, small stones, and moderate shrink-swell potential. The potential for recreational uses is low because of surface gravel.

These soils are in capability subclass VIs, nonirrigated, and in the Foothill Slope range site.

**22—Lozier association, rolling.** The soils in this association are very shallow and shallow, rolling, stony and gravelly soils on limestone hills. Slopes range from 5 to 15 percent. Soil areas are oblong, oval, or irregular in shape and range from 60 to several thousand acres.

Lozier soils make up 60 to 80 percent of the map unit, and Rock outcrop makes up 5 to 20 percent. Other soils make up 10 to 20 percent of the map unit. Limestone Rock outcrop occurs along a few sharp ledges or steep slopes and breaks. These areas are so similar in use and management that mapping them separately is not justified.

The Lazier soils have a surface layer of very gravelly loam, cobbly loam, or stony loam. Typically, they have a surface layer about 11 inches thick of very gravelly loam with about 40 percent by volume limestone gravel. This layer is pale brown in the upper part and light gray in the lower part. It rests abruptly on fractured limestone bed-rock coated with caliche. As much as 20 percent of the surface is covered with stones.

Lozier soils are well drained. Runoff is medium to rapid. Permeability is moderate. Available water capacity is very low. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Other soils of this association are areas of Delnorte, Hodgins, Reakor, and Upton soils and areas of a soil similar to Lozier soils that has less than 35 percent coarse fragments. Delnorte and Upton soils are on the base of the hills. Hodgins and Reakor soils are in narrow valleys and drainageways.

Lozier soils are used as rangeland. They are not suited to irrigated cropland, hayland, pastureland, or orchard because of depth to bedrock, slope, and stones. The potential for growing native range plants is low because very low rainfall and very low available water capacity limit forage production. The potential for wildlife habitat is low.

These soils have low potential for most urban and recreational uses because of slope, depth to bedrock, and small stones.

These soils are in capability subclass VIIs, nonirrigated, and in the Limestone Hill and Mountain range site.

**23—Lozier-Rock outcrop association, steep.** This association consists of very shallow, stony soils on lime-stone hills and Rock outcrop. Slopes range from 20 to 45 percent, with almost vertical escarpments of lime-stone Rock outcrop. The areas are irregular to oval in shape and range from 55 to 500 acres.

Lozier stony loam makes up 50 to 70 percent of the map unit, and other soils make up as much as 20 percent. Rock outcrop makes up 20 to 40 percent. Lazier soils are on the crest and side slopes of hills. Limestone Rock outcrop is along sharp breaks and scarps. These soils and Rock outcrop are so similar in use and management that mapping them separately is not justified.

Typically, Lozier soils have a surface layer of pale brown stony loam 5 inches thick. This layer rests abruptly on fractured limestone bedrock. As much as 20 percent of the surface is covered with stones.

The soils in this association are well drained. Runoff is medium to rapid. Permeability is moderate. Available water capacity is very low. The hazard of water erosion is severe and the hazard of soil blowing is slight.

Other soils of this association are areas of Hodgins, Reakor, and Upton soils. Upton soils are on the base of hills. Hodgins and Reakor soils are in narrow valleys and along drainageways between hills.

Lozier soils are used as rangeland. They are not suited to irrigated cropland, hayland, pastureland, or orchard because of depth to bedrock, slope, and stones. The potential for native range plants is low because very low rainfall and very low available water capacity limit forage production. The potential for wildlife habitat is low.

These soils have low potential for most urban and recreational uses because of slope, depth to bedrock, and stones. Lozier soils are in capability subclass VIIs, nonirrigated, and in the Limestone Hill and Mountain range site. Rock outcrop is not classified.

**24—Mierhill association, hilly.** The soils in this association are shallow soils on ridges and dissected uplands. Slopes range from 10 to 16 percent. Soil areas are generally oval to irregularly oblong and range from about 50 to 1,000 acres.

Mierhill soils make up 50 to 70 percent of each mapped area and other soils make up 30 to 50 percent. These soils are so similar in use and management that mapping them separately is not justified.

The Mierhill soils have a surface layer of very gravelly sandy loam, very gravelly sandy clay loam, or very gravelly clay loam. Typically, they have a surface layer of neutral, grayish brown, very gravelly sandy loam about 10 inches thick. The next layer, to a depth of 18 inches, is reddish yellow, very gravelly sandy clay loam. This layer rests abruptly on pinkish white indurated caliche that grades to weakly cemented caliche with igneous fragments at a depth of about 24 inches.

Mierhill soils are well drained. Runoff is medium to rapid. Permeability is moderate. Available water capacity is very low. The hazard of water erosion is severe and the hazard of soil blowing is slight.

Other soils of this association are Brewster and Boracho soils. Brewster soils occur as oval areas on rounded igneous intrusions and make up 0 to 20 percent of each mapped area. Boracho soils are on positions in the landscape similar to Mierhill soils and make up 0 to 20 percent of each mapped area. A soil that has a very gravelly surface layer less than 20 inches thick over marl makes up 0 to 40 percent of each mapped area. This soil is on the lower part of the ridges and dissected hills.

Mierhill soils are used as rangeland. They are not suited to irrigated cropland because of shallow rooting depth, very low available water capacity, slope, and small stones. The potential for native range plants is medium. Very low rainfall, very low available water capacity, and shallow rooting depth limit forage production. The potential for wildlife habitat is medium.

Mierhill soils have low potential for most urban and recreational uses because of slope, depth to indurated caliche, small stones, and corrosivity to uncoated steel.

These soils are in capability subclass VIIs, nonirrigated, and in the Gravelly Hills range site.

**25—Monahans association, nearly level.** The soils in this association are deep, nearly level soils on outwash plains. They have convex and concave slopes with a gradient of less than 3 percent. Soil areas are irregular in shape and range from about 50 to 1,600 acres.

Monahans soils make up 60 to 90 percent of each mapped area, and other soils make up the rest. Monahans soils generally are on higher elevations than the other soils. These soils are so similar in use and management that mapping them separately is not justified.

Typically, Monahans soils have a surface layer of light brownish gray loam about 4 inches thick. The next layer, to a depth of 24 inches, is pale brown, calcareous loam. The underlying layer to a depth of 60 inches is light gray loam with about 50 percent by volume visible calcium sulfate and calcium carbonate. These soils are moderately alkaline throughout.

These soils are well drained. Runoff is slow and permeability is moderate. The available water capacity is moderate. The rooting zone is deep for lime tolerant plants and moderately deep for other plants. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are Hoban, Holloman, Reakor, and Orla soils, and areas of a soil similar to Monahans soils that has less than 5 percent calcium carbonate in the profile and has a subsoil of fine sandy loam.

The soils of this map unit are used as rangeland. They are suited to irrigated cropland, pastureland, hayland, or orchard. The potential for native range plants is medium because of very low rainfall. The potential for wildlife habitat is low.

These soils have high potential for most urban uses. The most limiting feature is moderate corrosivity to uncoated steel and concrete. The potential for recreational uses is moderate because of the dusty soil surface.

These soils are in capability subclass VIIe, nonirrigated, and in the Sandy Loam range site.

**26—Orla clay loam, 0 to 1 percent slopes.** This moderately deep, nearly level soil is on uplands. Soil areas are generally oval, although some are irregular in shape. They range from about 5 to 500 acres.

Typically, the soil has a surface layer of pale brown, saline clay loam about 15 inches thick. This layer rests abruptly on very pale brown, saline clay loam that contains about 15 percent crystalline gypsum and calcium carbonate. This underlying layer extends to a depth of more than 60 inches.

This Orla soil is well drained. Runoff is medium and permeability is moderate. Available water capacity is low. The rooting zone is moderately deep. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Reeves, Hoban, and Holloman soils. These included soils make up less than 20 percent of each mapped area.

This Orla soil is used mainly for irrigated cropland, but some areas are used as rangeland or for urban and commercial development. Cotton, alfalfa, barley, and wheat are the major crops. It is not suited to nonirrigated farming because of very low rainfall.

Major concerns of management are soil tilth and salinity. The potential for growing irrigated crops depends on

the quantity and salinity of the water used. A well designed irrigation system and proper application of irrigation water are essential. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

The potential for native rangeland is low. Very low rainfall and little runoff from higher areas, which has been reduced because of road and irrigation ditch construction, are limitations. The potential for wildlife habitat is low.

This soil has medium potential for most urban uses. Moderate shrink-swell potential, seepage, and corrosivity to uncoated steel are limiting features. Low strength is a limitation for local roads and streets. The potential for recreational uses is low because of the dusty soil surface.

This soil is in capability subclass IIIs, irrigated, and VIIs, nonirrigated, and in the Salty range site.

**27—Orla association, nearly level.** The soils in this association are on uplands. They are saline, gently sloping soils that are less than 20 inches thick over gypsiferous earth. Slopes range from 0 to 3 percent. Large soil areas are irregular in shape and small areas are generally oval. Areas range from 8 to 3,000 acres.

Orla soils make up 50 to 90 percent of each mapped area, and other soils make up 10 to 50 percent. These soils are so similar in use and management that mapping them separately is not justified.

The Orla soils in this association have a surface layer of loam, clay loam, or silt loam. Typically, they have a surface layer of saline, pale brown clay loam about 5 inches thick. This layer rests abruptly on a layer of very pale brown gypsiferous earth that extends to a depth of more than 60 inches.

These Orla soils are well drained. Runoff is medium. Permeability is moderate. Available water capacity is low. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are areas of Hoban, Reeves, Holloman, and Reakor soils. In some areas, especially in and near the city of Pecos, there are soils similar to Orla soils that have a surface layer of silty clay.

Most of the soils of this association are used as rangeland. The city of Pecos is in this map unit. Soils less than 10 inches thick over gypsiferous material are not suited to irrigated cropland because of the very shallow depth to gypsiferous earth. Orla soils thicker than 10 inches have medium potential for irrigated cropland.

The potential for growing native range plants is medium because of very low rainfall and soil salinity. The main native plants are salt tolerant plants such as alkali sacaton, fourwing saltbush, and twoflower lower trichloris (fig. 7). The potential for wildlife habitat is low.

*Figure 7.*—**An area of Orla association, nearly level, in the Salty range site.**

These soils have medium potential for most urban uses. Moderate shrink-swell potential, seepage, and corrosivity to uncoated steel are limitations. Low strength is a limitation for local roads and streets. Some areas are flooded during abnormally heavy rainfall. The potential for recreational uses is low because of the dusty soil surface.

These soils are in capability subclass VIIs, nonirrigated, and in the Salty range site.

**28—Patrole silt loam.** This deep, nearly level soil is on flood plains. Slopes are less than 1 percent. Soil areas are generally rectangular and range from about 25 to 500 acres.

Typically, this soil has a surface layer of saline, pinkish gray silt loam about 6 inches thick. The next layer, to a depth of 24 inches, is massive, saline, pinkish gray silt loam with about 50 percent by volume visible gypsum and other salts. From a depth of 24 to 60 inches is hard, massive, saline, brown clay that has about 30 percent by volume masses of gypsum and other salts. This soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. It is rarely flooded. Runoff is slow. Permeability is moderately slow. If irrigated, this soil can develop a perched water table above the clay layer. Available water capacity is low to very low depending on the salinity of the soil. The rooting zone is deep; however, roots do not easily penetrate the clay layer. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Gila, Pecos, and Toyah soils, and areas of a soil similar to Patrole soils that has a clayey subsoil at a depth of less than 20 inches. These soils make up less than 20 percent of each mapped area.

This Patrole soil is used as rangeland, irrigated cropland, and pastureland. A small area is used for urban development. Cotton, alfalfa, grain sorghum, and small grain are the major crops. A large part of this soil is idle cropland because of the low quantity and high salinity of irrigation water taken from the Pecos River in recent years. The soil is not suited to nonirrigated farming because of soil salinity and low rainfall. If good quality and sufficient quantity of irrigation water is available, leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve soil moisture. A well designed irrigation system, proper application of water, and a salinity control program are essential. Both surface and sprinkler irrigation systems can be used.

This soil has medium potential for growing native range plants because of very low rainfall and soil salinity. Salt tolerant plants such as alkali sacaton, fourwing saltbush, big sacaton, and twoflower trichloris are the major plants of this soil. The potential for rangeland wildlife habitat is low.

This soil has low potential for urban and recreational uses because of rare flooding and corrosivity to uncoated steel.

This soil is in capability subclass IVs, irrigated, and VI Is, nonirrigated, and in the Salty Bottomland range site.

**29—Pecos silty clay, saline.** This deep, nearly level soil is on flood plains. Slopes are less than 1 percent. Soil areas are rectangular and range from about 15 to 1,200 acres.

Typically, this soil has a surface layer of grayish brown silty clay about 1B inches thick. The underlying layer to a depth of 60 inches is light gray to light brownish gray clay. This soil is saline, calcareous, and moderately alkaline throughout.

Runoff is slow to ponded and permeability is very slow. Leaching of salts is very difficult because of very slow internal drainage. This soil generally is not suitable for cultivation. A few areas are being cultivated, where irrigation water is available so the soil can be leached. This soil is rarely flooded.

Included with this Pecos soil in mapping are small areas of Arno, Fatale, and Gila soils, and areas of soils similar to Pecos soils that have a dark surface layer and loamy subsoil above a depth of 40 inches. These included soils make up less than 20 percent of each mapped area.

This Pecos soil has medium potential for growing native range plants because of very low rainfall and soil salinity. Salt tolerant plants such as alkali sacaton, fourwing saltbush, big sacaton, and twoflower trichloris are the major plants of this soil. The potential for wildlife habitat is low.

This soil has low potential for urban and recreational uses because of rare flooding, high shrink-swell potential, and corrosivity to uncoated steel.

This soil is in capability subclass IVs, irrigated, and VIls, nonirrigated, and in the Salty Bottomland range site.

**30—Phantom association, nearly level.** The soils in this association are deep and nearly level on flats, valleys, and alluvial fans that drain igneous hills and mountains. Slopes range from 0 to 3 percent. Soil areas are irregular to elongated in shape and range from about 10 to 500 acres.

Phantom soils make up 60 to 90 percent of the map unit. Other soils make up the rest. These soils are so similar in use and management that mapping them separately is not justified.

The Phantom soils have a surface layer of clay loam, silty clay, or clay. Typically, they have a surface layer of clay loam about 19 inches thick that is grayish brown in the upper part and dark grayish brown in the lower part. From a depth of 19 to 44 inches is dark grayish brown clay. Below this to a depth of 60 inches is grayish brown clay loam. These soils are calcareous and moderately alkaline throughout.

Phantom soils are well drained. They are flooded very briefly every 2 to 5 years. Runoff is slow and permeability is moderately slow. Most areas receive runoff from higher adjacent soils. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are areas of Limpia, Verhalen, Mitre, and Hodgins. These soils make up less than 40 percent of each mapped area.

The soils in this association are not suited to nonirrigated cropland. They are used as rangeland. The potential for growing native range plants is high. Although rainfall is very low, these areas receive additional water as runoff from higher adjacent areas. The potential for rangeland wildlife habitat is medium.

Phantom soils have low potential for most urban uses because of common flooding, high shrink-swell potential, and corrosivity to uncoated steel. The potential for recreational uses is also low because of common flooding and the dusty soil surface.

These soils are in capability subclass VIs, nonirrigated, and in the Clay Flat range site.

**31—Reakor silty clay loam, 0 to 1 percent slopes. This deep,** nearly level soil is on irrigated outwash plains. The mapped areas are irregular in shape and range from about 6 to 1,700 acres.

Typically, the surface layer is light brown silty clay loam about 10 inches thick. The next layer is light brown silty clay loam about 26 inches thick. The underlying layer to a depth of 60 inches is pink clay loam that has common soft masses of calcium carbonate. This soil is moderately alkaline and calcareous throughout.

This soil is well drained. Permeability is moderate. Runoff is slow. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Hodgins silty clay loam, Upton gravelly loam, and areas of Reakor gravelly clay loam. The included soils make up less than 15 percent of each mapped area.

This Reakor soil is used for irrigated cropland, hay-land, and pastureland. The major crops are cotton, alfalfa, grain sorghum, wheat, and barley. Because of the low rainfall, this soil is not suited to nonirrigated farming.

Major concerns of management are soil tilth and salinity, The potential for irrigated crops depends on the quantity and salinity of the water used. A well designed irrigation system and proper application of irrigation water are essential. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduces the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

The potential for native rangeland is low. Very low rainfall and little runoff from higher adjacent areas, which has been reduced because of road and irrigation ditch construction, are limitations.

This soil has medium potential for most urban uses. Moderate shrink-swell potential, seepage, and corrosivity to uncoated steel are the major limitations. Low strength is a limitation for local roads and streets. Some areas flood during abnormally heavy rainfall. The potential for recreational uses is low because of the dusty soil surface.

This soil is in capability class I, irrigated, capability subclass VIIc, nonirrigated, and in the Loamy range site.

**32—Reakor association, nearly level.** The soils in this association are deep, nearly level soils on outwash plains. Slopes range from 0.5 to about 3 percent. Soil areas are irregular in shape and range from about 35 to several thousand acres.

Reakor soils make up 70 to 80 percent of the map unit (fig. 8). Other soils make up 20 to 30 percent. These soils are so similar in use and management that mapping them separately is not justified.

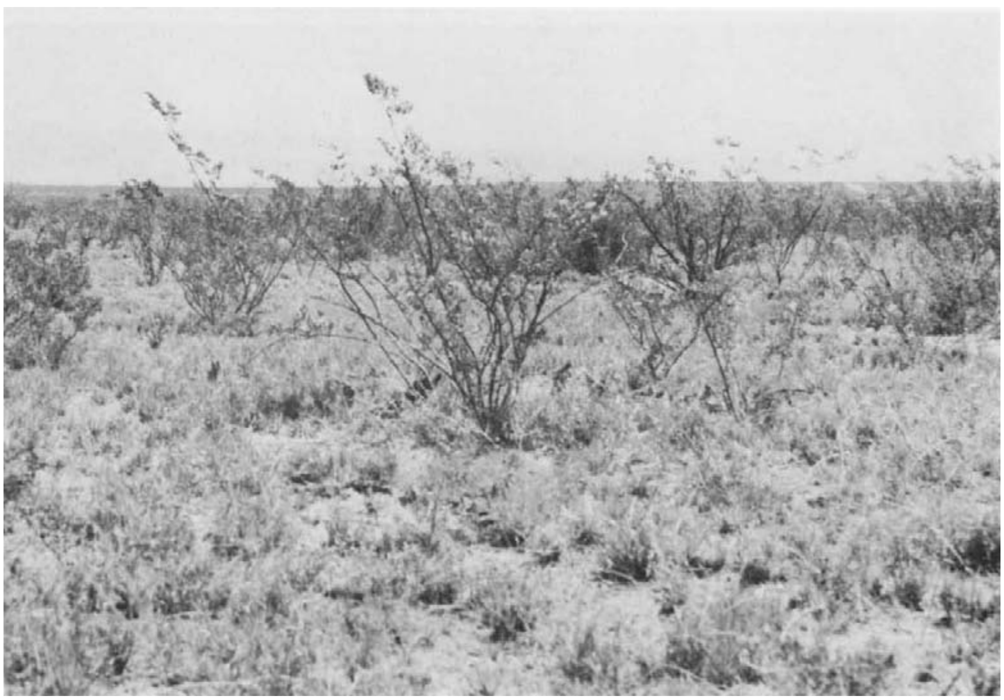

***Figure 8.*—An area of Reakor association, nearly level, in the Loamy range site.**

The Reakor soils have a surface layer of loam, silty clay loam, or clay loam. Typically, they have a surface layer of light brown loam about 8 inches thick. The next layer, to a depth of 24 inches, is light brown clay loam with a few threads of calcium carbonate. From 24 to 60 inches is pink clay loam with common concretions, soft masses, and threads of calcium carbonate. These soils are calcareous and moderately alkaline throughout.

Reakor soils are well drained. Runoff is moderately slow to slow. Permeability is moderate. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils in the association are areas of Reeves, Hoban, Hodgins, Nickel, Monahans, and Holloman soils. Monahans, Holloman, Reeves, Hoban, and Hodgins soils are on similar positions in the landscape as Reakor soils. Gravelly Nickel soils are on oval-shaped hills at higher elevations. Also in this association are some soils similar to Reakor soils that have caliche at a shallow depth.

The soils of this association are used as rangeland. These soils are suited to irrigated cropland where water of sufficient quantity and good quality is available. They are not suited to nonirrigated farming because of very low rainfall. The potential for growing native range plants is medium because of very low rainfall. Characteristic

native vegetation is blue grama, black grama, and burro-grass. The potential for rangeland wildlife habitat is low.

Reakor soils have medium potential for most urban uses because of corrosivity to uncoated steel and moderate shrink-swell potential. The potential for recreational uses is low because of the dusty soil surface.

These soils are in capability subclass VIIc, nonirrigated, and in the Loamy range site.

**33—Reakor-Lozier association, undulating.** The soils in this association are deep, shallow and very shallow, undulating soils on outwash plains and uplands. Slopes range from 1 to 8 percent. Soil areas are irregular in shape and range from about 80 to several thou-sand acres.

Reakor soils, which have slopes of 2 percent or less, make up 40 to 50 percent of each mapped area and are on concave slopes in the lower part of the areas. Lozier soils, which have slopes of 2 to 8 percent, make up 25to 35 percent of each mapped area and are on the higher convex slopes of the areas (fig. 9). Hodgins soils make up about 10 to 25 percent of each mapped area and are in the narrow drainageways between hills. Other soils make up as much as 15 percent of each mapped area. These soils are so similar in use and management that mapping them separately is not justified.

***Figure 9.*—An area of Reakor-Lozier association, undulating. Reakor soils, on the lower, dark areas, are in the Loamy range site. Lozier soils, on the higher, light areas, are in the Limestone Hill and Mountain range site.**

Typically, Reakor soils have a surface layer of light brownish gray loam about 4 inches thick. The next layer, to a depth of 29 inches, is light yellowish brown clay loam. The underlying layer to a depth of 60 inches is very pale brown clay loam with about 50 percent by volume calcium carbonate concretions and masses. These soils are calcareous and moderately alkaline throughout.

Reakor soils are well drained. Runoff is moderately slow to slow and permeability is moderate. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Typically, Lozier soils have a surface layer of moderately alkaline, light brownish gray, calcareous stony loam about 8 inches thick over limestone bedrock. As much as 20 percent of the surface is covered with stones.

Lozier soils are well drained. Runoff is moderate to rapid and permeability is moderate. Available water capacity is very low. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Other soils in this association are small areas of a moderately deep soil over indurated caliche, and small areas of Monahans, Upton, and Holloman soils.

The soils of this association are used as rangeland. Non-irrigation farming is not suited. Lozier soils are not suited to irrigated cropland. Reakor soils are suited to irrigated cropland; however, the areas are small and runoff from the Lazier soils could cause erosion on cultivated fields. The potential of the Reakor soils for native range plants is medium because of very low rainfall, and the potential of the Lozier soils is low because of low rainfall, shallow rooting zone, and very low available water capacity. The potential for wildlife habitat is low.

The potential of Reakor soils for urban uses is medium. Moderate shrink-swell potential and corrosivity to uncoated steel are limitations. Lazier soils have low potential for urban uses. Depth to bedrock is a limitation. The potential for recreational uses is low for these soils. Reakor soils are dusty and Lazier soils have small stones.

The Reakor soils are in capability subclass VIIc, nonirrigated, and Lozier soils are in capability subclass VIIs, nonirrigated. Reakor soils are in the Loamy range site and Lozier soils are in the Limestone Hill and Mountain range site.

**34—Reeves clay loam, 0 to 1 percent slopes.** This deep, nearly level soil is on uplands. Soil areas are irregular in shape and range from 10 to 1,600 acres.

Typically, this soil has a surface layer of pale brown clay loam about 11 inches thick. The next layer, to a depth of 33 inches, is light yellowish brown clay loam. From 33 to 60 inches is very pale brown clay loam that has about 50 percent by volume concretions and masses of gypsum and calcium carbonate. This soil is calcareous and moderately alkaline throughout.

This Reeves soil is well drained. Runoff is medium. Permeability is moderate above the gypsum layer and variable in the gypsum layer. Available water capacity is high. The rooting zone is deep; however, roots penetrate the gypsum layer with difficulty. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Reeves loam and Reeves silty clay loam. Also included are areas of Orla and Hoban soils. The included soils make up less than 20 percent of each mapped area.

The soils in this map unit are used mainly as irrigated cropland. A few areas are used as rangeland. The major crops are cotton, alfalfa, grain sorghum, and barley. The soils are not suited to nonirrigated farming because of very low rainfall.

The potential for growing irrigated crops depends on the quantity and salinity of water used. Major limitations of this soil are soil tilth and salinity. A well designed irrigation system and proper application of irrigation water are essential. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

The potential for rangeland is medium. Very low rain-fall and little runoff from higher adjacent areas, which has been reduced because of road and irrigation ditch construction, are limitations. The potential for wildlife habitat is low.

This soil has medium potential for most urban uses. Moderate shrink-swell potential, seepage, and corrosivity to uncoated steel and concrete are limitations. Low strength is a limitation for local roads and streets. Some areas may flood during abnormally heavy rainfall. The potential for recreational uses is low because of the dusty soil surface.

This Reeves soil is in capability subclass IIIs, irrigated, and VIIs, nonirrigated, and in the Loamy range site.

**35—Rockhouse association, nearly level.** The soils in this association are deep, nearly level soils on flood plains of draws that drain igneous hills and mountains. Slopes are 0 to 2 percent. Soil areas are generally oblong to long and narrow and range from 15 to 900 acres.

Rockhouse soils make up 60 to 85 percent of each mapped area, and Bigetty soils and riverwash make up 15 to 40 percent. These soils are so similar in use and management that mapping them separately is not justified.

The Rockhouse soils have a surface layer of loam, gravelly loam, or cobbly loam. Typically, they have a surface layer of neutral, brown gravelly loam about 14 inches thick. The underlying layer to a depth of more than 60 inches is neutral, brown very cobbly loamy sand.

These soils are well drained. They are flooded very briefly about 2 years in 3. Runoff is slow to medium. Permeability is rapid. Available water capacity is low. The hazards of water erosion and soil blowing are slight.

The soils in this association are used as rangeland. They are not suited to cropland because of frequent flooding and low available water capacity. The potential for growing native range plants is high because of runoff received from higher adjacent areas. Characteristic native vegetation is sideoats grama, cane bluestem, and vine-mesquite. The potential for wildlife habitat is medium.

These Rockhouse soils have low potential for urban and recreational uses because of frequent flooding.

These soils are in capability subclass VIs, nonirrigated, and in the Draw range site.

**36—Sanderson-Upton association, gently sloping.** The soils in this association are deep and shallow soils on uplands. Slopes range from 1 to 5 percent. Soil areas are irregularly oblong and range from 15 to 150 acres.

Sanderson soils make up 50 to 70 percent of each mapped area, and Upton soils make up 30 to 40 percent. Sanderson soils are on the younger surfaces of fans on slopes away from hills. Upton soils are on the higher, older sloping fans at the base of hills. Other soils make up as much as 20 percent of each mapped area. These soils are so similar in use and management that mapping them separately is not justified.

Typically, Sanderson soils have a surface layer of grayish brown gravelly loam about 5 inches thick. The next layer, to a depth of 17 inches, is light brownish gray gravelly loam. Between a depth of 17 to 60 inches is light reddish brown very gravelly loam. These soils are calcareous and moderately alkaline throughout.

Typically, Upton soils have a surface layer of yellowish brown gravelly loam about 6 inches thick. The next layer, to a depth of 18 inches, is light yellowish brown gravelly loam. The substratum is very pale brown indurated caliche.

The soils in this association are well drained. Runoff is medium and permeability is moderate. Available water capacity is low in Sanderson soils and very low in Upton soils. The hazard of water erosion is moderate and the hazard of soil blowing is slight.

Other soils in this association are small areas of Hodgins and Reakor soils. These soils are in narrow drainage ways.

The soils in this association are used as rangeland. They have low potential for growing irrigated crops be-cause of the low and very low available water capacity. The potential for growing native range plants is low because of the very low rainfall. Characteristic native vegetation is bush muhly, black grama, slim tridens, and Wright threeawn. The potential for rangeland habitat is medium.

The potential of the Sanderson soils for most urban uses is low because of small stones and corrosivity to uncoated steel. Upton soils have low potential for most urban uses because of corrosivity to uncoated steel and shallow depth to cemented or indurated caliche. These soils have medium potential for recreational uses because of small stones on the surface.

Sanderson soils are in capability subclass VIs, nonirrigated. Upton soils are in capability subclass VIIs, nonirrigated. Both are in the Gravelly range site.

**37—Saragosa association, nearly level.** The soils in this association are shallow soils over gypsiferous material. They occur on uplands in depressional areas. Slopes are less than 1 percent. Soil areas are irregular in shape and range from 100 to several thousand acres.

Saragosa soils make up 80 to 90 percent of the mapped areas. They occur as continuous bodies within which are elliptical areas of Holloman soils and long, narrow and oval areas of Orla soils. Areas of Holloman and Orla soils are 5 to 50 acres and make up 5 to 20 percent of the mapped areas. Other soils make up less than 5 percent of the areas. These soils are so similar in use and management that mapping them separately is not justified.

Saragosa soils have a surface layer of silt loam, loam, clay loam, or silty clay loam. Typically, they have a surface layer of extremely saline, brown clay loam about 4 inches thick. This layer rests abruptly on extremely saline, white gypsiferous material that is soft in the upper part and weakly cemented in the lower part. This layer extends to a depth of more than 60 inches.

The Saragosa soils are poorly drained. They are flooded briefly one year in every 5 to 10 years. Runoff is very slow. Permeability is moderate. Available water capacity is very low because of extreme salinity. The hazard of water erosion is slight and the hazard of soil blowing is moderate. A seasonal, extremely saline high water table is at a depth of 2 to 4 feet sometime during the fall, winter, or spring each year.

Other soils of this association are areas of Balmorhea soils, which make up less than 5 percent of any one mapped area.

Saragosa soils are not suited to irrigated or nonirrigated cropland because of extreme salinity. These soils are used as rangeland or for housing and commercial development. The potential for growing native range plants is low. Only plants with a very high salt tolerance grow on this soil. Native vegetation is dominantly pickleweed with scattered fourwing saltbush, mesquite, and alkali sacaton. The soil is subject to occasional flooding. The potential for wildlife habitat is low.

The soils in this association have low potential for most urban and recreational uses because of depth to gypsum, occasional flooding, and depth to the high water table.

These soils are in capability subclass VIIIs, nonirrigated. These soils are not classified in a range site.

**38—Toyah loam.** This deep, nearly level soil is on flood plains. Slopes average less than 0.5 percent. Soil areas are long and narrow to irregular in shape and range from about 12 to 1,000 acres.

Typically, this soil has a surface layer of brown loam about 7 inches thick. From a depth of 7 to 60 inches is clay loam that is grayish brown in the upper part and strong brown in the lower part. This soil is saline, calcareous, and moderately alkaline throughout.

This soil has moderate permeability and is well drained. It is rarely flooded. Available water capacity is high. The hazard of water erosion is slight and the hazard of soil blowing is moderate. The rooting zone is deep and easily penetrated by plant roots.

Included with this soil in mapping are small areas of Toyah clay loam, soils similar to Toyah soils that have sandy loam subsurface horizons, and soils that have a light colored surface layer. These included soils make up as much as 25 percent of each mapped area.

Most of the soil in this map unit is used for growing irrigated crops. A few areas are used for housing, commercial development, or range. Cotton, alfalfa, grain sorghum, and small grain are the major crops. This soil is not suited to nonirrigated farming because of very low rainfall.

The potential for growing irrigated crops depends on the quantity and salinity of the water used. Major limitations of this soil are soil tilth and salinity. A well designed irrigation system and proper application of irrigation water are needed. Both surface and sprinkler irrigation systems can be used. However, if the irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving crop residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

The potential for converting cultivated areas back to native rangeland is low. Very low rainfall and little runoff from higher adjacent areas, which has been reduced by diversion, road, and irrigation ditch construction, are limitations.

If this soil is in native rangeland, the potential for growing native range plants is high. Low rainfall is a limitation; however, this soil receives runoff and produces more forage than most other soils. The potential for wildlife habitat is medium.

The potential for most urban and recreational uses is low. This soil is subject to flooding during abnormally heavy rainfall. Other limitations are corrosivity to uncoated steel and moderate shrink-swell potential.

This Toyah soil is in capability subclass IIw, irrigated, and VIw, nonirrigated, and in the Draw range site.

**39—Toyah clay loam.** This deep, nearly level soil is on flood plains and alluvial fans. Slopes are less than 1 percent. Soil areas are irregular in shape and range from about 5 to 1,100 acres.

Typically, the surface layer is dark grayish brown clay loam about 16 inches thick. The underlying layer to a depth of more than 60 inches is light brownish gray sandy clay loam with a few strata of clay loam. This soil is calcareous and moderately alkaline throughout.

This soil is well drained. It is subject to rare flooding during the rainy season in areas not protected by diversions. Available water capacity is high. The rooting zone is deep and easily penetrated by plant roots. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Balmorhea clay loam, Toyah loam, and Verhalen clay. Also included are areas of a soil similar to the Toyah soil that has a light colored surface layer. The included soils make up less than 10 percent of each mapped area.

Most of the soil in this map unit is used as cropland. Major crops are cotton, alfalfa, grain sorghum, small grains, and grasses. Some areas are used as rangeland or for housing and commercial development. This soil is not suited to nonirrigated farming because of very low rainfall.

Major limitations of this soil are soil tilth and salinity. The potential for growing irrigated crops depends on the quantity and salinity of the water used. A well designed irrigation system and proper application of irrigation water are needed. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving crop residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

The potential for converting cultivated areas back to native rangeland is low. Very low rainfall and little runoff from higher adjacent areas, which has been reduced because of road and irrigation ditch construction, are the limiting factors.

The potential for growing native range plants is high. Low rainfall is a limitation; however, this soil receives runoff and produces more forage than most other soils. The potential for rangeland wildlife habitat is medium.

The potential for urban uses, if the soil is protected from flooding, is medium. Moderate shrink-swell potential is a limitation. Low strength is a limitation for local roads and streets. The potential for recreational uses is medium if the soil is protected from flooding. The dusty soil surface is a limitation. If the soil is not protected from flooding, the potential for urban and recreational uses is low.

This soil is in capability subclass IIw, irrigated, and VIw, nonirrigated, and in the Draw range site.

**40—Toyah clay loam, saline.** This deep, nearly level soil is on flood plains. Slopes average about 0.5 percent. Soil areas are irregular in shape and range from 40 to several hundred acres.

Typically, this soil has a surface layer of grayish brown clay loam about 14 inches thick. The underlying layer to a depth of 60 inches is light brown sandy clay loam with thin strata of silt loam and loam. This soil is calcareous and moderately saline throughout.

This soil is well drained. It is subject to rare flooding during abnormally heavy rainfall. Runoff is medium. Permeability is moderate. Available water capacity is moderate because of soil salinity. The rooting zone is deep and easily penetrated by plant roots. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Pecos, Arno, Gila, and Patrole soils. Also included are areas of a soil similar to Toyah soils that has a light colored surface layer. The included soils make up less than 20 percent of each mapped area.

Most of the soil in this map unit is or has been used for irrigation. Some areas are used as rangeland. Major crops are cotton, alfalfa, barley, or such pasture grasses as bermuda or blue panicum. This soil is not suited to nonirrigated farming because of very low rainfall.

Major limitations of this soil are soil tilth and salinity. The potential for growing irrigated crops depends on the quantity and salinity of the water used. A well designed irrigation system and proper application of irrigation water are essential. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving crop residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

This soil has medium potential for growing native range plants because of low rainfall and rare overflow. Native range plants are alkali sacaton, fourwing saltbush, vine-mesquite and giant sacaton. The potential for wild-life habitat is low.

This soil has low potential for most urban uses because of rare flooding, moderate shrink-swell potential, and corrosivity to uncoated steel. The potential for recreational uses is medium because of the dusty soil surface.

This soil is in capability subclass IIIs, irrigated, and VIIs, nonirrigated, and in the Salty Bottomland range site.

**41—Upton gravelly loam, 0 to 2 percent slopes.** This shallow, nearly level soil is on uplands. Surfaces are plane to convex. Soil areas are oval to irregular in shape and range from 5 to 300 acres.

Typically, this soil has a surface layer of gravelly loam about 12 inches thick that is brown in the upper part and yellowish brown in the lower part. The next layer, to a depth of 18 inches, is light yellowish brown gravelly loam. The underlying layer to a depth of 60 inches is pink to pinkish white caliche that is indurated in the upper part and soft in the lower part. This soil is calcareous and moderately alkaline throughout.

This soil is well drained. Runoff is medium and permeability is moderate. Available water capacity is very low. The hazards of water erosion and soil blowing are slight.

Included with this soil in mapping are areas of gravelly Delnorte soils which are generally on small oval-shaped hills at slightly higher elevations. Also included are areas of a soil similar to the Upton soil that has less than 15 percent gravel in the profile. Other soils in small areas are Hoban silty clay loam, Reeves clay loam, and Reakor silty clay loam. These included soils make up 10 to 20 percent of each mapped area.

This soil is used as irrigated cropland and rangeland. Cotton, alfalfa, grain sorghum, and small grain are the major crops.

This soil has low potential for growing irrigated crops because of very low available water capacity and shallow rooting depth. The areas in cultivation are small areas that are included in large fields of soils that are better suited to cultivation. Good management practices include leaving crop residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops. A well designed irrigation system, proper application of irrigation water, and salinity control are essential. Surface and sprinkler irrigation systems can be used. However, if the salinity of the water exceeds 4 millimhos per centimeter, sprinkler systems can result in leaf burn.

The potential for converting cropland to rangeland is low. Very low rainfall and lack of runoff from higher adjacent areas, which has been reduced because of road and irrigation ditch construction, are limitations. The potential for wildlife habitat is medium if the soil is irrigated, and low elsewhere.

This soil has low potential for growing native range plants because of very low rainfall and very low available water capacity.

The potential for most urban uses is low because of depth to indurated caliche and corrosivity to uncoated steel. The potential for most recreational uses is medium because of the dusty soil surface and small stones.

This soil is in capability subclass IVs, irrigated, and VIIs, nonirrigated, and in the Gravelly range site.

**42—Upton-Delnorte association, nearly level.** The soils in this association are very shallow and shallow, nearly level soils on uplands. Slopes are 0 to 2 percent. Soil areas range from 10 to several thousand acres.

Upton soils make up 40 to 50 percent, and Delnorte soils make up 30 to 40 percent of each mapped area. Upton soils are on lower positions in the landscape and Delnorte soils are on higher positions. Other soils comprise up to 30 percent of each mapped area. These soils are so similar in use and management that mapping them separately is not justified.

Typically, Upton soils have a surface layer of light brownish gray loam about 4 inches thick. The next layer, to a depth of 12 inches, is pale brown gravelly loam. The substratum is indurated caliche. These soils are calcareous and moderately alkaline throughout.

Typically, Delnorte soils have a surface layer of light brownish gray, moderately alkaline, calcareous, very gravelly loam about 6 inches thick. The underlying layer is indurated caliche.

Upton and Delnorte soils are well drained. Runoff is medium from Upton soils, and rapid from Delnorte soils. Permeability is moderate above the indurated caliche layer. Internal drainage is restricted by the indurated caliche layer. Available water capacity is very low.

Other soils in this association are small areas of Reakor soils and a soil similar to Upton soils that has indurated caliche at a depth of 20 to 30 inches.

The soils in this association are not suited to irrigated cropland because of very low available water capacity and a high volume of gravel. These soils are used mainly as rangeland, but the potential for growing native range plants is low. Low rainfall, low available water capacity, and little runoff from higher adjacent areas limit forage production. The potential for rangeland wildlife habitat is low.

The soils in this association have low potential for most urban uses because of depth to hard caliche and corrosivity to uncoated steel. The potential for recreational uses is low because of surface gravel.

These soils are in capability subclass VIIs, nonirrigated, and in the Gravelly range site.

**43—Verhalen clay.** This deep, nearly level soil is on outwash plains. Slopes are less than 1 percent. Surfaces are plane to concave; however, there is a slight gilgai microrelief of microknolls and microdepressions. Soil areas are somewhat rectangular and range from 5 acres to several thousand acres.

Typically, this soil has a surface layer of grayish brown clay about 10 inches thick. The next layer, to a depth of 43 inches, is brown clay. The underlying layer to a depth of 60 inches is pink calcareous clay with common soft masses and concretions of calcium carbonate and gypsum. This soil is saline, calcareous, and moderately alkaline throughout.

Verhalen clay is moderately well drained. It is subject to rare flooding. Runoff is slow and permeability is very slow. Water enters rapidly when the soil is dry and cracked, and enters very slowly when the soil is wet and the cracks are sealed. Available water capacity is moderate. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Delnorte, Hoban, Hodgins, Limpia, and Reakor soils. Also included are areas of soils similar to Verhalen soils that have very gravelly layers below a depth of 30 inches and do not have the gilgai microrelief. These included soils make up as much as 25 percent of each mapped area.

This Verhalen soil is used as rangeland and irrigated cropland, hayland, and pastureland. Cotton, barley, and alfalfa are the major crops. This soil is not suited to nonirrigated farming because of very low rainfall.

Major limitations of this soil are soil tilth and salinity. The potential for growing irrigated crops depends on the quantity and salinity of the water used. A well designed irrigation system and proper application of irrigation water is needed. Both surface and sprinkler irrigation systems can be used. However, if irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation can result in leaf burn.

Leaving residue on the surface when crops are not being grown, timely and limited tillage, and rotation of crops help control soil blowing and water erosion and help conserve moisture. Crop residue also helps maintain soil productivity and reduce the amount of salt coming to the surface through evaporation of water from the surface. A leaching program based on the salt tolerance of the crop grown and salinity of the irrigation water is needed. Refer to the section "Use and management of the soils" for more information on these and other management concerns.

This soil has high potential for growing native range plants. Low rainfall is a limitation, although most areas receive runoff from adjacent areas. Characteristic native range plants are tobosa, vine-mesquite, blue grama, and cane bluestem. The potential for rangeland wildlife habitat is medium.

This soil has low potential for urban and recreational areas because of corrosivity to uncoated steel, high shrink-swell potential, very slow permeability, and a clayey surface. This soil is subject to rare flooding during abnormally heavy rainfall.

This Verhalen soil is in capability subclass IIs, irrigated, and VIs, nonirrigated, and in the Clay Flat range site.

**44—Verhalen assoclation.** The soils in this association are deep, nearly level soils on broad areas of outwash plains near igneous hills and mountains. Slopes are mostly less than 1 percent. Soil areas are irregular in shape and range from 200 to several thousand acres.

Verhalen cobbly clay soils make up 50 to 60 percent of each mapped area, and Verhalen clay soils make up 20 to 40 percent. The Verhalen cobbly clay soils are on slightly higher positions in the landscape. Other soils make up as much as 20 percent of each mapped area. These soils are so similar in use and management that mapping them separately is not justified.

Typically, the Verhalen soils have a surface layer of brown cobbly clay about 8 inches thick. About 80 percent of the surface is covered with cobbles and gravel. The next layer, to a depth of 38 inches, is brown clay. The underlying layer to a depth of 60 inches is pinkish gray clay with soft masses of calcium carbonate. These soils are calcareous, moderately alkaline, and moderately saline to strongly saline.

Verhalen clay is similar to Verhalen cobbly clay except that it has up to 5 percent gravel and cobbles on the surface and in the surface layer. This soil also has a gilgai microrelief, and the cracks are deeper and wider when dry than in Verhalen cobbly clay.

Verhalen soils are moderately well drained and slowly permeable. They are subject to rare flooding. Runoff is slow. Available water capacity is medium. The hazard of water erosion is slight and the hazard of soil blowing is moderate.

Other soils of this association are small oval or elongated areas of Limpia and Mitre soils, and areas of soils similar to Verhalen soils that have very gravelly layers below a depth of 30 inches and where gilgai microrelief is absent.

The Verhalen cobbly clay soils are not suited to irrigated cropland because of a large number of cobbles. Verhalen clay soils are suited to irrigated cropland. All of the soils of this association are used for rangeland.

These soils have high potential for growing native plants. Their potential is limited only by low rainfall. Where the soils receive runoff from the adjoining slopes, forage production is higher. Characteristic native range plants are tobosa, vine-mesquite, blue grama, and cane bluestem. The potential is medium for rangeland wildlife habitat.

These soils have low potential for urban and recreational uses. They are corrosive to uncoated steel, have high shrink-swell potential, very slow permeability, and a surface layer of clay. These soils are subject to flooding during abnormally heavy rainfall.

These soils are in capability subclass VIs, nonirrigated, and in the Clay Flat range site.

# Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, play-grounds, lawns, and trees and shrubs.

## Crops

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Soil maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 159,704 acres of Reeves County was used for irrigated cropland in 1967, according to the Conservation Needs Inventory (3). By 1976, this had dropped sharply to about 25,000 acres of irrigated cropland.

All cropland is irrigated. The rainfall is too low for nonirrigated farming. The most restrictive factors limiting the use of Reeves County soils for irrigated cropland are the salinity and the availability of irrigation water. Another factor, which is not soil related, is the high cost of producing irrigated crops. Several thousand acres of land that was previously irrigated has become idle because the cost of production is more than sale value of the crops (fig. 10). Some areas have been planted to grass without irrigation, but the degree of success has been variable.

***Figure 10.*—An idle field of Hoban silty clay loam, 0 to 1 percent slopes. This field was previously irrigated cropland.**

Other soil management concerns are the hazard of soil blowing, soil tilth, and the management of irrigation water.

Soil blowing is a moderate hazard on the clayey Verhalen and Dalby soils and on the loamy Balmorhea, Hoban, Hodgins, Gila, Orla, Reakor, Patrole, Reeves, and Toyah soils. Maintenance of a vegetative cover, of surface mulch, or of rough surfaces through proper tillage minimizes soil blowing.

Loss of the surface layer by soil blowing is damaging for two reasons. First, productivity is reduced as the surface layer is lost and the less fertile subsoil is incorporated into the plow layer. Second, soil blowing results in pollution of the air during dust storms. This causes health hazards and safety hazards on roads and highways.

A conservation cropping system that keeps a vegetative cover on the soil surface for extended periods can hold soil losses to amounts that do not reduce the productive capacity of the soil. Minimum tillage and leaving crop residue on the soil surface helps reduce the hazard of soil blowing.

Emergency tillage, which roughens the soil surface so that it will be more resistant to movement by wind, helps control soil blowing when crop residue does not furnish adequate protection. Normal plowing operations following clean-tilled crops will leave the surface rough enough to minimize soil blowing. It will remain rough during the winter and spring. If the area is left idle during the next year, summer rains will dissolve the clods on the surface and the area will be subject to blowing the following spring unless plowed again.

Soil tilth is an important factor in the germination of seeds, the emergence of seedlings, and the movement of water and air in the soil. Clayey soils, such as the Verhalen and Dalby soils, can become very hard and compacted in the surface layer and in the subsoil. This restricts the movement of roots, water, and air in the soil. Hoban, Hodgins, Reakor, and Reeves soils have high amounts of silt and calcium carbonates. This causes the soil to form hard crusts on the surface, restricting seedling emergence and the entrance of air and water into the soil. Crop residue management, stubble mulching, cover crops, growing high residue crops, and minimum tillage help improve and maintain good tilth on these soils.

Irrigated crops need additions of fertilizer to obtain the best yields. The irrigated soils in the county respond well to fertilization. Additions of fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer to apply. The soils in Reeves County do not require additions of lime.

Irrigation water management is needed to obtain the best yields from irrigation without wasting water. Concrete-lined ditches or underground pipelines are used to prevent the loss of water as it flows from the well to the field. Proper row length is important to get an even distribution and penetration of water down the row, and to prevent water from running out the end of the row. Water should be applied before the plants go into stress. Enough water should be applied to satisfy the needs of the plant, plus some extra water to leach salts below the root zone.

Information on irrigation water management and leaching practices for each kind of soil is available in local field offices of the Soil Conservation Service in Pecos and Balmorhea.

Field crops suited to the soils and climate of Reeves County are cotton, alfalfa, barley, wheat, and grain sorghum. Specialty crops are cantaloupes, onions, and bell peppers. Sunflowers and safflower have been grown in irrigated areas with varying degrees of success.

The latest information on and suggestions for growing field crops or specialty crops can be obtained from the local offices of the Soil Conservation Service and the Cooperative Extension Service.

### Irrigation and salinity

All cultivated cropland and hayland in the county is irrigated. The annual rainfall is too low to produce nonirrigated crops and hay. Most of the land is irrigated with water from wells that have pumping depths of 200 to 600 feet. Other areas are irrigated with surface water. One area is irrigated with water from Red Bluff Reservoir on the Pecos River. This irrigated acreage fluctuates from year to year depending on the quantity and quality of water stored in the reservoir.

Another area is irrigated with spring water stored in Balmorhea Lake. This water has an electrical conductivity of about 2 millimhos per centimeter, or 1,280 parts per million dissolved solids.

The major salinity problem is in the areas that are irrigated with ground water. Electrical conductivity of the ground water ranges mainly from 2.5 to 4.5 millimhos per centimeter, or from 1,280 to 5,120 parts per million dissolved solids. The electrical conductivity of water from some wells is as high as 10 millimhos per centimeter, but the well water has a sodium absorption ratio of 4 to about 8 and so the soluble sodium content is not a hazard.

Salinity of the irrigation water directly affects the salinity of the soil to which it is applied. The lower the electrical conductivity of the water, the fewer soluble salts that are in the water. The electrical conductivity of the soil can be predicted from the electrical conductivity of the water used. If the electrical conductivity of the irrigation water is 2 millimhos per centimeter or less, the predicted electrical conductivity of the soil is less than 4 millimhos per centimeter. If the electrical conductivity of the irrigation water is 2.1 to 4 millimhos per centimeter, the predicted electrical conductivity of the soil is 4 to 8 millimhos per centimeter. If the electrical conductivity of the irrigation water is 4 to 7.5 millimhos per centimeter, the predicted electrical conductivity of the soil is 8 to 16 millimhos per centimeter. If the electrical conductivity of the irrigation water is more than 7.5 millimhos per centimeter, the predicted electrical conductivity of the soil is more than 16 millimhos per centimeter.

Selecting crops that are suited to the predicted electrical conductivity of the soil is an important consideration. Table 6 shows the relative salt tolerance of some of the crops grown in the county (6).

The predicted electrical conductivity of the soil is based on a leaching program that will keep soil salinity within that range. To do this, water beyond what the crops require is applied. This amount is not enough to damage the crops by flooding or to result in runoff from the system. The amount of water required for leaching depends on the efficiency of the irrigation system, the salinity of the irrigation water, and the salt tolerance of the crop. This amount can be as much as 10 to 50 percent of the consumptive use of the crop.

The annual rainfall is not sufficient to leach the salts out of the root zone. Unless irrigated soils are leached, even though water of low salinity is used, the soil eventually becomes too saline for most crops.

Soils such as the Hoban, Balmorhea, Hodgins, Reeves, Reakor, and Toyah soils are well drained and are permeable enough so that a considerable amount of water can be applied for leaching. Soils that are very slowly permeable, such as the Verhalen and Dalby soils, can be damaged by waterlogging of the soil if too much water is applied. In addition, much of the water is lost through runoff. Therefore, irrigation water that has an electrical conductivity greater than 4 millimhos per centimeter is not recommended for use on Verhalen and Dalby soils.

Additional information on soil and water salinity management can be obtained from the local offices of the Soil Conservation Service.

### Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 7. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 7 are grown in the survey area, but estimated yields are not listed be-cause the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

### Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland and for engineering purposes.

In the capability system, soils are generally grouped at two levels: capability class and subclass (7). These levels are defined in the following paragraphs.

*Capability classes,* the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to *remove, that* limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

*Capability subclasses* are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or c because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to rangeland, wildlife habitat, or recreation. (There are no class V soils in Reeves County.)

The acreage of soils in each capability class and sub-class is indicated in table 8. All soils in the survey area except those named at a level higher than the series are included. Some of the soils that are well suited to crops may be in low-intensity use, for example, soils in capability classes I and II. Data in this table can be used to determine the farming potential of such soils if sufficient water of good quality is available for irrigation. If water with an electrical conductivity of less than 2 millimhos per centimeter is available, the following soils are in capability class I: Balmorhea silty clay loam; Hoban silty clay loam, 0 to 1 percent slopes; Hodgins silty clay loam, 0 to 1 percent slopes; Reakor silty clay loam, 0 to 1 percent slopes; Toyah loam; and Toyah clay loam.

## Rangeland

Winfred R Bauer, range conservationist, Soil Conservation Service. assisted in preparing this section.

About 90 percent of Reeves County is range. More than half of the farm income is derived from livestock, principally cattle. Cow-calf-yearling operations are dominant throughout the county, and cow-calf-steer-yearling operations are prevalent in the southern part. The average ranch is about 18,000 acres.

On many ranches the forage produced on rangeland is supplemented by hay and protein concentrate. Creep feeding of calves and yearlings to increase market weight is practiced on some ranches.

The native vegetation in many parts of the survey area has been greatly depleted by continued excessive use. Much of the acreage that was once open grassland is now covered with brush, weeds, and other undesireable plants. The amount of forage produced may be less than 25 percent of that originally produced. Productivity of the range can be increased by using management practices that are effective for specific kinds of soil and range sites.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 9 shows, for each soil in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 9 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

*Total production* is the amount of vegetation that can be expected to grow annually on well managed range-land that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally be-cause of low available soil moisture.

*Dry weight* is the total annual yield per acre reduced to a common percent of air dry moisture.

*Characteristic vegetation*—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition,* the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Most of the county has gravelly loamy soils that are shallow over hard or cemented caliche. Most of these soils are on low hills and potential productivity is low because of the shallow rooting depth and runoff. Between the shallow gravelly soils on the hills are deep, loamy soils that receive runoff from adjoining higher areas. The potential productivity of the soils is medium to high. In the southern and southwestern parts of the county the soils are shallow, gravelly and stony loamy soils over limestone or igneous bedrock. The productivity is medium to low. These areas receive the highest annual precipitation in the county.

There are large areas of loamy soils that are underlain with gypsiferous material at depths of 3 to 20 inches. Where these soils are saline, the productivity is low. The non-saline areas have moderate productivity.

If grazing is controlled, the kinds of plants that made up the original climax plant community can be re-established. This is a major rangeland management concern. Controlling brush, range seeding, and controlling water erosion and soil blowing are also important management concerns. The potential is good for increasing the productivity of range in the area if sound range management, based on the soil survey information and range-land inventories, is applied.

## Recreation

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

*Camp* areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

*Playgrounds* require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

*Paths and trails* for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

## Wildlife habitat

Willard Richter. biologist, Soil Conservation Service, assisted in preparing this section.

The major wildlife species in the county are dove, quail, roadrunner, jackrabbit, cottontail rabbit, and coyote. Mule deer and antelope are found in the southern and western parts of the county. Most of the county is considered rangeland wildlife habitat. However, some areas in the irrigated parts of the county have good potential for openland wildlife habitat. The economics of irrigation should be considered before establishing these habitats.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. If the soils have the potential and water is available, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be established, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

*Grain and seed crops* are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

*Grasses and legumes* are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

*Wild herbaceous plants* are native or naturally established grasses and forbs, including weeds. Soil proper-ties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, wheatgrass, and grama.

*Shrubs* are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are mountainmahogany, snowberry, and big sagebrush.

*Wetland plants* are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

*Shallow water areas* have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

*Habitat for openland wildlife* consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include scaled quail, pheasant, meadowlark, field spar-row, cottontail, and red fox.

*Habitat for wetland wildlife* consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

*Habitat for rangeland wildlife* consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland includes antelope, deer, and meadowlark.

## Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

*Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.*

*The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.*

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

### Building site development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and with-out basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

*Shallow excavations* are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

*Dwellings and small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

*Local roads and streets* have an all weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and depth to a high water table affect the traffic supporting capacity.

**Sanitary facilities**

Table 13 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

*Septic tank absorption fields* are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

*Sewage lagoons* are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

*Sanitary landfills* are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

*Daily cover for landfill* is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill, Clayey soils are sticky or cloddy and are difficult to spread; loamy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

**Construction materials**

The suitability of the soils as a source of roadfill, sand, gravel, and topsoil is indicated in table 14 by ratings of *good, fair,* or *poor.* The ratings are based on soil proper-ties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties (table 17) provides detailed information about each soil layer. This information can help determine the suit-ability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated good contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated poor have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

*Sand and gravel are* used in great quantities in many kinds of construction. The ratings in table 14 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good or fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in the table on engineering index properties.

*Topsoil* is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

**Water management**

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

*Pond reservoir areas* hold water behind a dam or embankment. Soils best suited to this use have low seep-age potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

*Embankments, dikes, and levees* are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

*Drainage* is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and subsidence of organic layers. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

*Irrigation* is the controlled application of water to supplement rainfall and support plant growth. The design

and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

*Terraces and diversions* are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

*Grassed waterways* are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

## Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some bench-mark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 16.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

## Engineering index properties

Table 17 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

*Depth* to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

*Texture* is given in the standard terms used by the U.S. Department of Agriculture (5). These terms are de-fined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

*Classification* of the soils is determined according to the Unified soil classification system (Unified) (2) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (1).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC: silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16. The estimated classification, without group index numbers, is given in table 17.

*Rock fragments* larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

*Percentage (of soil particles) passing designated sieves* is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

*Liquid limit* and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

## Physical and chemical properties

Table 18 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

*Permeability* refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

*Available water capacity* refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

*Soil reaction* is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

*Salinity* is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by *the* quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

*Shrink-swell potential* is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture con-tent is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; and *high,* more than 6 percent. Very *high,* greater than 9 percent, is sometimes used.

*Risk of corrosion* pertains to potential soil induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K in this survey range from 0.10 to 0.49. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

*Erosion factor T* is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

*Wind erodibility groups* are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility of soil to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 per-cent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

## Soil and water features

Table 19 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

*Hydrologic soil groups* are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water trans-mission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

*Flooding,* the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 19 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil pro-file, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

*High water table* is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 19 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

*Depth to bedrock* is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

*Cemented pans* are hard subsurface layers, within a depth of 5 or 6 feet, that are strongly compacted (indurated). Such pans cause difficulty in excavation. The hardness of pans is similar to that of bedrock. A rippable pan can be excavated, but a hard pan generally requires blasting.

### Engineering index test data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and morphology."

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM). Laboratory test procedures may cause minor differences in shrinkage limit, liquid limit, and the computed plasticity index.

The tests and methods are: AASHTO classification-M 145 (AASHTO), D 3282 (ASTM); Unified classification-D 2487 (ASTM); Mechanical analysis-T 88 (AASHTO), D2217 (ASTM); Liquid limit-T 89 (AASHTO), D 423(ASTM); Plasticity index-T 90 (AASHTO), D 424 (ASTM); Specific gravity (particle density)-T 100 (AASHTO), D 653 (ASTM); Shrinkage-T 92 (AASHTO), D 427 (ASTM).

## Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (8). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 20, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll *(Ust,* meaning dry, plus *oll,* from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons;

soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Calciustolls *(Calci,* meaning horizons high in carbonates, plus *ustoll,* the suborder of the Mollisols that have an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extra-grades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Calciustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, thermic Typic Calciustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

## Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (5). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (8). Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

### Arno series

The Arno series consists of deep, moderately well drained, clayey soils on flood plains. These soils formed in calcareous, saline, clayey alluvium. Slope is less than 1 percent.

Typical pedon of Arno silty clay in an area of Arno-Pecos-Patrole association, from the intersection of U.S. Highway 285 and Interstate 20 in Pecos, 1.6 miles south-east on U.S. Highway 285, 8.4 miles east on Farm Road 1450, 2.5 miles north on an oilfield road, and 0.4 mile west, in range:

A—0 to 11 inches; light brown (7.5YR 6/4) silty clay, brown (7.5YR 4/4) moist; massive; hard, firm, sticky; common fine roots; about 20 percent by volume gypsum crystals; strongly saline; calcareous; moderately alkaline; clear smooth boundary.

C1—11 to 25 inches; reddish brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) moist; moderate fine subangular blocky structure; very hard, very firm, very sticky; few fine roots; about 10 percent by volume gypsum crystals: strongly saline; calcareous; moderately alkaline; clear smooth boundary.

C2—25 to 41 inches; reddish brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) moist; massive; very hard, very firm, very sticky; few fine pores; about 5 percent by volume gypsum crystals; strongly saline; calcareous; moderately alkaline; abrupt wavy boundary.

C3—41 to 60 inches; light gray (5Y 7/2) silty clay loam, olive gray (5Y 5/2) moist; few fine distinct yellowish brown mottles; massive; hard, friable, sticky; about 10 percent by volume gypsum crystals; strongly saline; calcareous; moderately alkaline.

The soil is more than 100 inches thick. The solum is moderately saline to extremely saline. When the soil is dry, cracks from 0.4 to 0.8 inch wide extend to depths of more than 20 inches. Clay content of the control section ranges from 40 to 60 percent.

The A horizon is 6 to 14 inches thick. It is light brown, light brownish gray, pale brown, brown, pinkish gray, reddish gray, light reddish brown, or reddish brown clay, silty clay, or silty clay loam. The volume of visible gypsum crystals ranges from 0 to 30 percent.

The C horizon is reddish brown, light gray, light brownish gray, brown, gray, pink, pinkish gray, light reddish brown, or olive yellow. Mottles are not present in some pedons. The C horizon is silty clay, clay, or silty clay loam. Thin lenses of silt loam or clay loam up to 2 inches thick are present in some pedons. The volume of gypsum crystals ranges from 3 to 50 percent.

## Balmorhea series

The Balmorhea series consists of deep, somewhat poorly drained, loamy soils on flood plains. These soils formed in calcareous, silty and loamy alluvium. Slope ranges from 0 to 1 percent.

Typical pedon of Balmorhea silty clay loam, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 1.8 miles southwest on U.S. Highway 290, 0.15 mile southeast on a county road, and 25 feet south-west of the road, in a cultivated field:

Ap—0 to 18 inches; very dark gray (10YR 311) silty clay loam, black (10YR 2/1) moist; moderate fine subangular blocky structure; hard, friable, very sticky, plastic; common fine roots; common fine pores; about 3 percent by volume tufa fragments mostly less than 1/2 inch in diameter; few fine snail shell fragments; calcareous; moderately alkaline; gradual wavy boundary.

A1—18 to 28 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine subangular blocky structure; hard, friable, very sticky, plastic; common fine roots; common fine pores; about 5 percent by volume tufa fragments mostly less than 3/4 inch in diameter; few fine snail shell fragments; calcareous; moderately alkaline; clear wavy boundary.

Ab—28 to 34 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; few fine distinct grayish brown (10YR 5/2) mottles; moderate fine and medium subangular blocky structure; hard, friable, sticky, plastic; common fine roots; common fine pores; about 15 percent by volume tufa fragments mostly less than 3/4 inch in diameter; few snail shell fragments; calcareous; moderately alkaline; clear wavy boundary.

C1—34 to 40 inches; gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) moist; common medium distinct gray (10YR 5/1) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable, sticky, plastic; common fine roots; common fine pores; about 10 percent by volume tufa fragments mostly less than 1 /2 inch in diameter; few fine snail shell fragments; calcareous; moderately alkaline; clear wavy boundary.

C2—40 to 54 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; common medium distinct yellowish brown (10YR 5/8) mottles; massive; hard, friable, sticky, plastic; few fine roots; few fine tufa fragments; few fine powdery masses of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C3—54 to 60 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; common medium distinct yellowish brown (10YR 5/8) mottles; massive; hard, friable, sticky, plastic; few fine tufa fragments; few fine powdery masses of calcium carbonate; calcareous; moderately alkaline.

The solum is 24 to 48 inches thick. The 10 to 40-inch control section is silty clay loam or clay loam containing 28 to 35 percent silicate clay. Buried layers of silty clay or clay are common. The mollic epipedon is 21 to 48 inches thick. The volume of tufa and snail shell fragments In most pedons is 1 to 20 percent. In some pedons are thin strata that have up to 50 percent tufa fragments. Mottles of gray, grayish brown, yellowish brown, and yellowish red range from none to common throughout the pedon. Salinity ranges from slight to extreme.

The A horizon is very dark gray, dark gray, dark grayish brown, gray, grayish brown, or brown. It is clay, silty clay, silty clay loam, or clay loam and is granular or subangular blocky in structure.

The C horizon is very dark grayish brown, gray, light brownish gray, pale brown, or light gray. It is clay, silty clay, clay loam, or silty clay loam.

## Bigetty series

The Bigetty series consists of deep, well drained, loamy soils on flood plains along draws below igneous hills and mountains. These soils formed in mixed alluvium derived from acid and basic igneous rock and limestone rock. Slope is 0 to 1 percent.

Typical pedon of Bigetty loam in an area of Bigetty-Rockhouse association, from the intersection of Inter-state 10 and Farm Road 2903, 2 miles north of Balmorhea, 3.8 miles west on Interstate 10 access road, 0.5mile north on a private road, 2.5 miles northwest on a private road, and 50 feet east, in range:

A11—0 to 3 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, friable; common fine roots; few fine pores; neutral; clear smooth boundary.

A12—3 to 15 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable; common fine roots; calcareous; mildly alkaline; clear smooth boundary.

A13—15 to 35 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable; calcareous; moderately alkaline; gradual smooth boundary.

C—35 to 60 inches; brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; massive; slightly hard, friable; calcareous; moderately alkaline.

The mollic epipedon is 28 to 45 inches thick. Clay content of the control section is 18 to 35 percent.

The A horizon is brown, grayish brown, or dark grayish brown loam, silty clay loam, or clay loam.

The C horizon is grayish brown or brown loam, silt loam, or silty clay loam.

## Boracho series

The Boracho series consists of shallow, well drained, calcareous, very gravelly, loamy soils on uplands. These soils formed in gravelly outwash material. Slope ranges from 0 to 8 percent.

Typical pedon of Boracho very gravelly loam in an area of Boracho-Espy association, undulating, from the intersection of Interstate 10 and Farm Road 2903, 2.0 miles north of Balmorhea, 13.7 miles west on Interstate 10 to the U.S. Highway 290 exit, 0.1 mile south on U.S. Highway 290, on the side of a gravel pit on the northwest side of U.S. Highway 290, in range:

A1—0 to 12 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; weak fine platy structure in upper 2 inches, moderate fine subangular blocky in lower part; slightly hard, friable, non-sticky; common fine roots; about 50 percent by volume igneous and limestone fragments (45 percent gravel and 5 percent cobbles); calcareous; moderately alkaline; abrupt wavy boundary.

C1cam—12 to 20 inches; very pale brown (10YR 8/3) caliche, upper 5 inches indurated, laminar in the upper 1 /4 inch; lower part strongly cemented caliche and igneous and limestone fragments; clear wavy boundary.

C2ca—20 to 60 inches; very pale brown (10YR 7/3) very gravelly loam; massive; weakly cemented; 65 percent by volume igneous and limestone fragments 1 /4 inch to 6 inches in diameter.

Indurated caliche is at a depth of 10 to 18 inches. The soil is calcareous and moderately alkaline throughout.

The A horizon is grayish brown or brown, very gravelly loam or very gravelly clay loam. The volume of igneous and limestone coarse fragments is 35 to 60 percent (30 to 60 percent gravel and 0 to 5 percent cobbles).

The C1cam horizon is 6 to 15 inches thick. It is white, pinkish white, or very pale brown. Some pedons lack the lamination in the upper part, but have a hardness of more than 3 on Moh's scale.

## Brewster series

The Brewster series consists of very shallow and shallow, well drained, stony, gravelly, and loamy, undulating to steep soils on uplands. These soils formed in materials weathered from bedrock of igneous hills and mountains. Slope ranges from 10 to 40 percent.

Typical pedon of Brewster very gravelly loam, in an area of Brewster association, hilly, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 2.8 miles southwest on U.S. Highway 290, 0.05 mile east on a county road, t35 miles southeast on a county road, 0.25 mile southwest on a private road, and 50 feet south, in range:

A1—0 to 6 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2)moist; moderate fine subangular blocky structure; slightly hard, friable; many fine roots; about 50 percent by volume igneous fragments (30 percent gravel, 10 percent cobbles, and 10 percent stones); calcareous; mildly alkaline; abrupt wavy boundary.

R—6 to 12 inches; igneous bedrock with few fractures.

The soil is 4 to 18 inches thick over igneous bedrock.

The A horizon is grayish brown, dark grayish brown, very dark grayish brown, reddish gray, or dark reddish gray loam or clay loam. The volume of coarse fragments ranges from 35 to 80 percent (25 to 50 percent gravel, 0 to 20 percent cobbles, and 0 to 20 percent stones). Reaction is neutral or mildly alkaline. Some pedons are noncalcareous.

The R horizon is rhyolitic or trachytic volcanic rock. A few films or distinct patchy coatings of calcium carbon-ate are on the faces of fracture planes in the bedrock of some pedons. Total secondary carbonates are less than 5 percent.

## Canutio series

The Canutio series consists of deep, well drained, very gravelly, loamy soils on uplands. These soils formed in loamy, gravelly igneous and limestone alluvial material. Slope ranges from 1 to 3 percent.

Typical pedon of Canutio very gravelly loam in an area of Canutio-Delnorte complex, 1 to 3 percent slopes, from the junction of Texas Highway 17 and Farm Road 1215in Saragosa, 5 miles north on Texas Highway 17, 3 miles west on a county road, 1.5 miles south on a county road, and 0.2 mile west, in a gravel pit:

A1—0 to 8 inches; light yellowish brown (10YR 6/4) very gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; weak fine granular structure; slightly hard, very friable, nonsticky; common fine roots; about 70 percent of surface covered by rounded igneous gravel; about 40 percent by volume rounded igneous gravel in the horizon; calcareous; moderately alkaline; clear wavy boundary.

C—8 to 60 inches; very pale brown (10YR 7/4) very gravelly sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, nonsticky; few fine roots; about 70 percent by volume rounded igneous gravel coated with caliche; calcareous; moderately alkaline; abrupt wavy boundary.

The soil is more than 60 inches thick. From 30 to 75 percent of the surface has a cover of rounded igneous and limestone gravel. The soil is calcareous and moderately alkaline throughout.

The A horizon is 4 to 18 inches thick. It is brown, yellowish brown, or light yellowish brown very gravelly loam or very gravelly sandy loam.

The C horizon is light brownish gray, light yellowish brown, or very pale brown very gravelly sandy loam or very gravelly loam. Clay content averages less than 18 percent. Gravel content ranges from 35 to 80 percent. In most pedons the pebbles are coated with caliche.

## Dalby series

The Dalby series consists of deep, well drained, clayey soils on uplands. These soils formed in calcareous, clayey, valley fill alluvium. Slope is 0 to 1 percent.

Typical pedon of Dalby clay, from the intersection of Interstate 20 and Farm Road 2903 in Toyah, 4 miles south on Farm Road 2903, and 315 feet west, in pasture:

A1—0 to 10 inches; pinkish gray (7.5YR 6/2) clay, brown (7.5YR 4/2) moist; moderate fine subangular blocky structure; very hard, very firm, plastic; common roots; few sandstone pebbles on the surface; calcareous; moderately alkaline; clear wavy boundary.

AC—10 to 26 inches; brown (7.5YR 5/2) clay, brown (7.5YR 4/2) moist; weak fine and medium blocky structure; very hard, very firm, plastic; many roots; common parallelepipeds; common slickensides mostly less than 4 inches across; few pebbles mostly less than 1/2 inch in diameter; saline; calcareous; moderately alkaline; clear wavy boundary.

C1ca—26 to 36 inches; light brown (7.5YR 6/4) silty clay, brown (7.5YR 5/4) moist; massive; very hard, very firm, plastic; few roots; few fine calcium carbon-ate concretions; few pebbles; saline; calcareous; moderately alkaline; clear wavy boundary.

C2ca—36 to 60 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; massive; hard, friable; few roots; few calcium carbonate concretions; few pebbles coated with caliche; saline; calcareous; moderately alkaline.

The soil is more than 60 inches thick. When the soil is dry, cracks 1 to 4 inches wide extend to a depth of 20 to more than 30 inches. Salinity ranges from nonsaline to moderately saline in the A1 horizon, and from slightly saline to extremely saline in the lower horizons. Gilgai microrelief ranges from 3 to 10 inches in undisturbed areas.

The A1 horizon is 6 to 12 inches thick. It is pinkish gray, brown, pale brown, light brown, grayish brown, or reddish brown clay or silty clay.

The AC horizon is 12 to 30 inches thick. It is brown, light brown, pale brown, or reddish brown clay or silty clay. Some pedons have films, threads, and soft masses of calcium carbonate or gypsum in the lower part.

The C horizon is light brown, pink, light yellowish brown, reddish yellow, very pale brown, or yellowish brown clay, silty clay, clay loam, or silty clay loam. Most pedons have secondary carbonates and many have gypsum in this horizon.

## Delnorte series

The Delnorte series consists of very shallow and shallow, well drained, very gravelly, loamy soils on uplands. These soils formed in calcareous, gravelly material. Slope ranges from 0 to 12 percent.

Typical pedon of Delnorte gravelly loam in an area of Delnorte-Nickel association, rolling, from the intersection of U.S. Highway 285 and Interstate 20 in Pecos, 1.6 miles southeast on U.S. Highway 285, 8 miles east on Farm Road 1450, then 2.8 miles north on a gravel road, and 800 feet west, in a gravel pit:

A11—0 to 5 inches; pale brown (10YR 6/3) gravelly loam, brown (10YR 4/3) moist; weak very fine subangular blocky structure; soft to slightly hard, very friable, slightly sticky; few fine and medium roots; 25 percent by volume igneous pebbles and strongly cemented caliche fragments 1/4 to 1 inch in diameter; calcareous; moderately alkaline; clear wavy boundary.

A12—5 to 12 inches; very pale brown (10YR 7/3) very gravelly loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; soft, very friable; few fine roots; about 60 percent by volume strongly cemented caliche fragments 1/2 inch to 2 1/2 inches in diameter; calcareous; moderately alkaline; abrupt wavy boundary.

C1cam—12 to 32 inches; very pale brown (10YR 8/3) strongly cemented caliche (hardness more than 3 on Moh's scale), very pale brown (10YR 7/3) moist; strongly cemented caliche fragments and plates with few imbedded igneous pebbles 1/4 to 1 inch in diameter: calcareous; clear wavy boundary.

C2—32 to 80 inches; light gray (10YR 7/2) gravelly loam, grayish brown (10YR 5/2) moist; massive; 50 to 60 percent by volume weakly cemented caliche, 15 to 25 percent caliche gravel, and a few igneous pebbles.

The soil above the petrocalcic horizon is 6 to 17 inches thick. The volume of coarse fragments in the control section ranges from 35 to 65 percent. The fragments are mostly less than 3 inches in diameter. From 25 to 90 percent of the surface has a cover of igneous, limestone, or caliche fragments.

The A horizon is 3 to 17 inches thick. It is pale brown, light brown, light brownish gray, pinkish gray, very pale brown, or brown. The A horizon is very gravelly or gravelly sandy loam or loam.

Some pedons have a Bca or Cca horizon between the A and C1cam horizons.

The C1cam horizon is 7 to 29 inches thick. It is white, very pale brown, or pinkish gray. The C1cam horizon is strongly cemented in the upper 3 to 5 inches, becoming less hard with increasing depth.

## Ector series

The Ector series consists of very shallow and shallow, well drained, moderately permeable soils on limestone hills and ridges. They formed in loamy material weathered from limestone bedrock. Slope ranges from 5 to about 30 percent.

Typical pedon of Ector very gravelly loam in an area of Ector association, hilly, from the intersection of Interstate 20 and Farm Road 2903 in Toyah, 19 miles southwest on Interstate 20, 1 mile west of Stocks exit on access road, 50 feet north of fence, in range:

A11—0 to 4 inches; grayish brown (10YR 5/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate very fine subangular blocky and weak granular structure; slightly hard, friable; common fine roots; about 50 percent by volume limestone fragments (35 percent gravel, 10 percent cobbles, and 5 percent stones); calcareous; moderately alkaline; clear smooth boundary.

A12—4 to 9 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; moderate very fine subangular blocky structure; slightly hard, friable; common fine roots; about 40 percent by volume limestone fragments (30 percent gravel and 10 percent cobbles); calcareous; moderately alkaline; abrupt smooth boundary.

R&Cca—9 to 17 inches; fractured limestone bedrock with caliche coatings on the sides of the fractures; gradual wavy boundary.

R—17 to 25 inches; fractured limestone bedrock.

The A horizon is 5 to 18 inches thick to limestone bedrock. It is brown, grayish brown, or dark grayish brown. Exclusive of coarse fragments, it is silt loam, loam, or clay loam, with clay content ranging from 15 to 35 percent. Coarse fragments of gravel, cobbles, and stones cover 80 to 90 percent of the surface. The volume of limestone fragments in the A horizon is 35 to 80 percent (30 to 75 percent gravel, 5 to 35 percent cobbles, and 0 to 20 percent stones).

## Espy series

The Espy series consists of shallow, well drained, calcareous, gravelly soils on uplands. These soils formed in gravelly outwash. Slope ranges from 1 to 5 percent.

Typical pedon of Espy gravelly loam in an area of Boracho-Espy association, undulating, from the intersection of Interstate 10 and Farm Road 2903, 2 miles north of Balmorhea, 17.5 miles west on Interstate 10, 1.3 miles southwest of the exit on a private road, and 50 feet northwest, in range:

A1—0 to 7 inches; grayish brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine platy structure in upper part, moderate fine subangular blocky in lower part; slightly hard, friable, slightly sticky; common fine roots; about 15 percent by volume igneous gravel; calcareous: moderately alkaline; clear smooth boundary.

B2—7 to 17 inches; pale brown (10YR 6/3) gravelly loam, brown (10YR 4/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky; few fine roots; few films and threads of calcium carbonate;

about 20 percent by volume igneous gravel; calcareous; moderately alkaline; abrupt wavy boundary.

C1cam—17 to 24 inches; pinkish white (7.5YR 8/2) caliche, indurated in upper 3 inches, strongly cemented below; about 15 percent by volume igneous gravel; clear *wavy* boundary.

C2ca—24 to 60 inches; very pale brown (10YR 8/3) very gravelly loam, very pale brown (10YR 7/3) moist; weakly cemented; about 40 percent by volume caliche fragments and igneous gravel; calcareous; moderately alkaline.

The soil is 11 to 20 inches thick to indurated caliche. It is calcareous and moderately alkaline throughout. Clay content of the control section is 18 to 30 percent.

The A horizon is 7 to 11 inches thick. It is grayish brown, brown, or dark brown gravelly loam or gravelly clay loam. The volume of igneous gravel is 15 to 25 percent.

The B2 horizon is 4 to 10 inches thick. It is pale brown, light brownish gray, or light brown gravelly loam or gravelly clay loam. The volume of igneous gravel is 15 to 30 percent.

The Ccam horizon is 6 to 16 inches thick. It is pale brown, pinkish white, or very pale brown.

## Gila series

The Gila series consists of deep, well drained, loamy soils on flood plains. These soils formed in recent alluvium. Slope is 0 to 1 percent.

Typical pedon of Gila fine sandy loam in an area of Gila-Patrole association, from the intersection of Farm Road 652 and U.S. Highway 285 in Orla, 5.5 miles north-east on Farm Road 652, and 100 feet north, in range:

A—0 to 11 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak fine granular structure; soft, very friable; common fine roots; moderately saline; calcareous: moderately alkaline; clear wavy boundary.

C1—11 to 21 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; massive; soft, very friable; few fine roots; few fine pores; moderately saline; distinct bedding planes; calcareous; moderately alkaline; abrupt wavy boundary.

C2—21 to 25 inches; brown (10YR 5/3) very fine sandy loam, brown (10YR 4/3) moist; massive; slightly hard, friable; few fine roots; moderately saline; calcareous; moderately alkaline; abrupt wavy boundary.

C3—25 to 37 inches; pale brown (10YR 6/3) loamy very fine sand, brown (10YR 5/3) moist; single grained; loose; moderately saline; calcareous; moderately alkaline; abrupt wavy boundary.

C4—37 to 60 inches; pale brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) moist; massive; slightly hard, friable; moderately saline; calcareous; moderately alkaline.

The soil is more than 60 inches thick. Salinity ranges from moderate to extreme. It is calcareous and moderately alkaline throughout. This soil has distinct stratification.

The A horizon is 7 to 12 inches thick. It is pale brown, light brownish gray, or grayish brown. The A horizon is loam, clay loam, fine sandy loam, loamy very fine sand, or very fine sandy loam.

The C horizon is pale brown or brown stratified loam, very fine sandy loam, loamy very fine sand, fine sandy loam, or silt loam. The average texture is loam or sandy loam. Clay content averages less than 18 percent.

## Hoban series

The Hoban series consists of deep, well drained, loamy soils on uplands. These soils formed in loamy or clayey gypsiferous material. Slope is 0 to 2 percent.

Typical pedon of Hoban silty clay loam, 0 to 1 percent slopes, from the intersection of Interstate Highway 20 and Texas Highway 17 in Pecos, 6.3 miles west on Interstate 20, 6.3 miles south on Farm Road 869, and 300 feet north of Pecos Experiment Station, Texas Agricultural Experiment Station, in a cultivated field on the east side of road:

Ap—0 to 8 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak fine granular and subangular blocky structure; hard, friable; few very fine roots; calcareous; moderately alkaline; abrupt smooth boundary.

A1—8 to 18 inches; brown (7.5YR 5/4) silty clay loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, friable; few very fine roots; common fine pores; calcareous; moderately alkaline; gradual smooth boundary.

B2ca—18 to 46 inches; pink (7.5YR 7/4) silty clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; hard, friable; few very fine roots; common fine pores; about 3 percent by volume films and threads of calcium carbonate; 23 percent calcium carbonate equivalent; few medium pebbles; calcareous; moderately alkaline; clear wavy boundary.

C1csca—46 to 60 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; massive; hard, friable; 40 to 50 percent by volume soft masses of gypsum and calcium carbonate; calcareous; moderately alkaline; diffuse wavy boundary.

C2csca—60 to 72 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; massive; hard, friable; 10 percent by volume soft masses of gypsum and calcium carbonate; calcareous; moderately alkaline.

The solum above the gypsic horizon is 40 to 60 inches thick. The calcic horizon is at a depth of 12 to 40 inches. The control section is clay loam, silty clay loam, silty clay, or clay with total clay content of 28 to 50 percent. The content of noncarbonate clay ranges from 20 to 35 percent.

The A horizon is 10 to 24 inches thick. It is light brownish gray, pale brown, very pale brown, light gray, pinkish gray, light brown, brown, or pink. In cultivated areas, the A horizon is slightly darker than in rangeland. The A horizon is clay loam, loam, silty clay loam, or silty clay.

The B horizon is 16 to 35 inches thick. It is light brownish gray, pale brown, light brown, pink, brown, yellowish brown, light yellowish brown, or very pale brown clay loam, silty clay loam, or silty clay. The volume of visible calcium carbonate masses ranges from 3 to 10 percent.

The C horizon is pink, pinkish white, pale brown, light yellowish brown, very pale brown, white, yellowish brown, light brown, or reddish yellow. It is clay loam, silty clay loam, silty clay, or clay. The volume of soft masses of gypsum and calcium carbonate ranges from 5 to 50 percent.

## Hodgins series

The Hodgins series consists of deep, well drained, loamy soils on uplands. These soils were formed in calcareous, loamy materials. Slope is 0 to 1 percent.

Typical pedon of Hodgins silty clay loam, 0 to 1 per-cent slopes, from the intersection of Texas Highway 17 and U.S. Highway 80 in Pecos, 8.3 miles south on Texas Highway 17, 1 mile west on a paved road, and 100 feet south, in a cultivated field:

Ap—0 to 8 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; very fine subangular blocky structure; slightly hard, firm; common fine roots; calcareous; moderately alkaline; abrupt smooth boundary.

B21—8 to 19 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; moderate fine subangular blocky structure; slightly hard, firm; common fine roots; calcareous; moderately alkaline; clear *wavy* boundary.

B22ca—19 to 36 inches; very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, firm, plastic; few fine roots; few films, threads, soft masses, and fine concretions of calcium carbonate; calcareous; moderately alkaline; diffuse wavy boundary.

B23ca—36 to 60 inches; light yellowish brown (10YR 6/4) silty clay, yellowish brown (10YR 5/4) moist; weak fine and medium subangular blocky structure; fine roots; few films, threads, and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum is more than 40 inches thick. Visible segregations of lime make up less than 5 percent of any horizon having its upper boundary within 40 inches of the surface.

The A horizon is 6 to 19 inches thick. It is yellowish brown, brown, pale brown, light brown, light brownish gray, grayish brown, or pinkish gray. The A horizon is clay loam, silty clay loam, silty clay, loam, or silt loam.

The B21 horizon is brown, yellowish brown, pale brown, very pale brown, light yellowish brown, or light brown silty clay loam, silty clay, or clay loam. The clay content ranges from 30 to 50 percent and the noncarbonate clay content ranges from 18 to 35 percent.

The B22ca and B23ca horizons are light yellowish brown, pink, reddish brown, very pale brown, brown, strong brown, reddish yellow, light brown, or pale brown. They are clay loam, silty clay, or silty clay loam.

## Holloman series

The Holloman series consists of shallow and very shallow, well drained, loamy soils on uplands. These soils formed in material weathered from gypsum and alluvial sediment. Slope ranges from 0 to 5 percent.

Typical pedon of Holloman loam in an area of Holloman-Reeves association, gently undulating, from the intersection of U.S. Highway 285 and Farm Road 652 in Orla, 11.1 miles northwest on U.S. Highway 285, 0.8 mile west on an oil field road, and 50 feet north, in range:

A1—0 to 6 inches; brown (7.5YR 5/2) loam, brown (7.5YR 4/2) moist; weak thin platy structure in upper 1 inch, weak fine subangular blocky below; slightly hard, very friable, slightly sticky; many fine and very fine roots; common very fine pores; calcareous; moderately alkaline; abrupt wavy boundary.

C1cs—6 to 12 inches; pink (7.5YR 7/4) gypsiferous loamy earth, light brown (7.5YR 6/4) moist; massive; soft, friable; few fine roots; common very fine pores; contains about 50 percent by volume gypsum crystals and soft masses; calcareous; moderately alkaline; clear wavy boundary.

C2cs—12 to 60 inches; yellowish brown (10YR 5/4) gypsiferous loamy earth, dark yellowish brown (10YR 4/4) moist; massive; very hard, very firm, sticky; about 30 percent by volume gypsum crystals and soft masses; calcareous; moderately alkaline.

The solum is 4 to 16 inches thick.

The A horizon is very pale brown, brown, light yellowish brown, pinkish gray, pale brown, or light brownish gray loam or silt loam.

The C horizon is pink, brown, white, yellowish brown, light brown, or pinkish white loam or silt loam. It is soft to cemented. Hardness is less than 3 on Moh's scale.

## Limpia series

The Limpia series consists of deep, well drained, cobbly, loamy soils on uplands. These soils formed in gravelly and cobbly, clayey materials on sloping fans and terraces below igneous hills and mountains. Slope ranges from 0 to 3 percent.

Typical pedon of Limpia cobbly loam in an area of Limpia-Mitre association, gently sloping, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 2.8 miles southwest on U.S. Highway 290, 0.05 mile east on a county road, and 3.5 miles southeast on a county road, in a gravel pit on the south side of the road:

A1—0 to 10 inches; brown (7.5YR 5/2) very cobbly loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable; common fine roots; about 60 percent by volume igneous fragments (25 percent gravel, 30 percent cobbles, and 5 percent stones); neutral; clear smooth boundary.

B21t—10 to 27 inches; reddish brown (5YR 5/3) very cobbly clay, dark reddish brown (5YR 3/3) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; thin clay films on ped faces; about 60 percent by volume igneous fragments (20 percent gravel, 35 percent cobbles, and 5 percent stones); neutral; gradual smooth boundary.

B22tca—27 to 57 inches; yellowish red (5YR 5/6) very cobbly clay, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; thin patchy clay films on peds; about 5 percent by volume concretions and soft masses of calcium carbonate; about 60 percent by volume caliche coated igneous fragments (35 percent gravel and 25 percent cobbles); calcareous; moderately alkaline; clear wavy boundary.

IIC1ca—57 to 72 inches; pink (7.5YR 7/4) loam, brown (7.5YR 5/4) moist; massive; slightly hard, very friable; about 50 percent by volume soft masses of calcium carbonate; calcareous; moderately alkaline.

The volume of coarse fragments in the control section ranges from 35 to 75 percent. The mollic epipedon is 20 to 31 inches thick.

The A horizon is 5 to 12 inches thick. It is reddish brown or brown. The A horizon is very gravelly or very cobbly loam, clay loam, or sandy clay loam.

The B2t horizon is very gravelly clay or very cobbly clay. The B2t horizon above the calcic horizon is reddish brown or dark reddish gray. The B2tca horizon is yellowish red, light yellowish brown, or brown. The volume of visible calcium carbonate ranges from 5 to 15 percent. A B2tca horizon is not present in some pedons.

The IIC1ca horizon, where present, is pink, pale brown, brown, or yellowish red. It is loam, silt loam, or sandy clay loam. The volume of visible calcium carbon-ate ranges from 30 to 60 percent.

## Lozier series

The Lozier series consists of very shallow and shallow, well drained, stony, loamy soils on limestone hills. These soils formed in material weathered from limestone. Slope ranges from 2 to 35 percent.

Typical pedon of Lozier very gravelly loam in an area of Lozier association, rolling, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 2.8 miles northeast, 12.8 miles east on Interstate 10, 1 mile south on a county road, and 50 feet east, in range:

A11—0 to 4 inches; pale brown (10YR 6/3) very gravelly loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist; common fine roots; about 40 percent by volume limestone pebbles; calcareous; moderately alkaline; gradual smooth boundary.

A12ca—4 to 11 inches; light gray (10YR 7/2) very gravelly loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; slightly hard, friable; common fine roots; about 40 percent by volume limestone pebbles; calcareous; moderately alkaline; abrupt smooth boundary.

R&Cca—11 to 19 inches; fractured limestone bedrock with caliche coatings on the surface and sides of fractures; gradual wavy boundary.

R—19 to 25 inches; fractured limestone bedrock.

The solum is 4 to 19 inches thick over limestone bedrock.

The A horizon is pinkish gray, pale brown, light brownish gray, light brown, pink, or grayish brown. It is very gravelly, cobbly, or stony loam. The weighted average volume of limestone fragments in the control section ranges from 38 to 60 percent (20 to 50 percent gravel, 0 to 20 percent cobbles, and 0 to 20 percent stones).

## Mierhill series

The Mierhill series consists of shallow, well drained, very gravelly, loamy soils on uplands. They formed in gravelly and stony alluvium. Slope ranges from 10 to 16 percent.

Typical pedon of Mierhill very gravelly sandy loam in an area of Mierhill association, hilly, from the intersection of Interstate 10 and Farm Road 2903, 2 miles north of Balmorhea, 0.4 mile west on north access road, 1.5 miles north on a private road, and 10 feet northeast, in range:

A1—C to 10 inches; grayish brown (10YR 5/2) very gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, friable; many fine roots; few fine pores; about 60 percent by volume rounded and slightly angular igneous fragments (50 percent pebbles and 10 percent cobbles); neutral; clear smooth boundary.

B2t—10 to 18 inches; reddish yellow (7.5YR 6/6) very gravelly sandy clay loam, light brown (7.5YR 6/4) moist; moderate fine subangular blocky structure; hard, friable; few fine roots; 75 percent by volume rounded and slightly angular igneous fragments (60 percent pebbles and 15 percent cobbles); calcareous; moderately alkaline; abrupt smooth boundary.

C1cam—18 to 24 inches; pinkish white (7.5YR 8/2) caliche, indurated and platy in upper four inches, strongly cemented in lower part; about 70 percent by volume rounded and slightly angular igneous fragments; calcareous; moderately alkaline; gradual smooth boundary.

C2ca—24 to 40 inches; white (10YR 8/2) caliche; weakly cemented; 70 percent by volume rounded and slightly angular igneous fragments; calcareous; moderately alkaline.

The soil is 12 to 18 inches thick over indurated caliche. The volume of coarse fragments in the A and B horizons ranges from 50 to 85 percent (45 to 70 percent gravel, 0 to 25 percent cobbles, and 0 to 10 percent stones).

The A horizon is 5 to 13 inches thick. It is very dark grayish brown, very dark brown, dark grayish brown, or grayish brown. The A horizon is very gravelly sandy loam, sandy clay loam, or clay loam.

The B2t horizon is 5 to 8 inches thick and is reddish brown, light reddish brown, reddish yellow, or light brown. It is very gravelly sandy clay loam or very gravelly clay loam. Clay content of the B2t horizon ranges from 18 to 35 percent.

The C1cam horizon is 5 to 18 inches thick. It is pinkish white, very pale brown, or white.

## Mitre series

The Mitre series consists of shallow, well drained, very gravelly, loamy soils on uplands. These soils formed in gravelly and stony materials of fans, terraces, and outwash plains. Slope is 0 to 2 percent.

Typical pedon of Mitre gravelly loam in an area of Limpia-Mitre association, gently sloping, from the inter-section of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 2.8 miles southwest on U.S. Highway 290, 0.05 mile east on a county road, and 3.5 miles southeast on a county road, in a gravel pit on the south side of the road (fig. 11):


***Figure 11.*—A profile of Mitre very gravelly loam showing an abrupt *wavy* boundary between the subsoil and the petrocalcic horizon.**

A1—0 to 4 inches; reddish brown (5YR 4/3) very gravelly loam, dark reddish brown (5YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable; many fine roots; contains about 50 percent by volume igneous fragments mostly 1/4 inch to 2 inches in diameter; neutral; clear smooth boundary.

B2t—4 to 10 inches; reddish brown (5YR 4/3) very gravelly clay loam, dark reddish brown (5YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable; common fine roots; 50 percent by volume igneous fragments 1/4 inch to 3 inches in diameter; neutral; abrupt wavy boundary.

Ccam—10 to 20 inches; pinkish white (5YR 8/2) indurated caliche, laminar in the upper 1/3 inch, strongly cemented in the lower part.

Indurated caliche is at a depth of 10 to 18 inches.

The A horizon is 3 to 7 inches thick. It is reddish brown or brown very gravelly loam and gravelly loam. The volume of igneous gravel ranges from 25 to 50 percent.

The B2t horizon is 6 to 12 inches thick. It is reddish brown very gravelly clay loam or very gravelly clay. The volume of igneous pebbles ranges from 40 to 50 percent.

The Ccam horizon is white, pinkish white, or pink. It is indurated or strongly cemented, with a hardness of more than 3 on Moh's scale.

## Monahans series

The Monahans series consists of deep, well drained, loamy soils on uplands. These soils formed in calcareous and gypsiferous alluvial materials. Slope is 0 to 3 percent.

Typical pedon of Monahans loam in an area of Monahans association, nearly level, from the intersection of U.S. Highway 285 and Farm Road 652 in Orla, 4.7 miles northeast on Farm Road 652, and 0.5 mile north on a private road, in range:

A—0 to 4 inches; light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; platy structure; slightly hard, friable; common fine roots; few limestone and igneous pebbles; calcareous; moderately alkaline; abrupt smooth boundary.

B21—4 to 13 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; few limestone and igneous pebbles; few fine calcium carbonate concretions; calcareous; moderately alkaline; clear wavy boundary.

B22ca—13 to 24 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; about 5 percent by volume visible soft deposits and threads of calcium carbonate; few caliche coated pebbles; calcareous; moderately alkaline; abrupt wavy boundary.

Ccacs—24 to 60 inches; light gray (10YR 7/2) loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, friable; about 50 percent by volume visible masses of calcium carbonate and gypsum; calcareous; moderately alkaline.

Depth of the soil to layers having secondary calcium carbonate and gypsum ranges from 13 to 30 inches. Clay content of the 10- to 40-inch control section ranges from 18 to 25 percent.

The A horizon is 4 to 12 inches thick. It is light brownish gray, very pale brown, light brown, pale brown, or light yellowish brown.

The B2 horizon is 7 to 24 inches thick. It is pale brown, very pale brown, or reddish yellow loam or sandy clay loam. In some pedons the B2 horizon has about 5 percent by volume soft masses of calcium carbonate.

The Ccacs horizon is light gray, very pale brown, pinkish gray, pinkish white, reddish yellow, or pink loam or sandy clay loam. The volume of visible gypsum and calcium carbonate ranges from 25 to 50 percent.

## Nickel series

The Nickel series consists of deep, well drained, very gravelly, loamy soils on uplands. These soils formed in very gravelly, loamy, calcareous sediment. Slope ranges from 2 to 12 percent.

Typical pedon of Nickel very gravelly sandy loam in an area of Delnorte-Nickel association, rolling, from the intersection of Interstate 20 and Farm Road 2903 in Toyah, 1.4 miles southeast on Farm Road 2903, in a gravel pit on the east side of the road:

A1—0 to 5 inches; pale brown (10YR 6/3) very gravelly sandy loam, brown (10YR 4/3) moist; weak fine granular and subangular blocky structure; slightly hard, very friable; common fine roots; about 50 percent by volume caliche coated igneous pebbles mostly 1/4 inch to 2 inches in diameter; calcareous; moderately alkaline; gradual smooth boundary.

C1—5 to 10 inches; pale brown (10YR 6/3) very gravelly sandy loam, brown (10YR 5/3) moist; weak fine and medium subangular blocky structure; hard, friable; few fine roots; about 50 percent by volume igneous pebbles 1/2 inch to 3 inches in diameter; calcareous; moderately alkaline; abrupt wavy boundary.

C2ca—10 to 22 inches; very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) moist; massive; hard, friable; few fine roots; 15 percent by volume visible soft masses of calcium carbonate; about 70 percent by volume strongly and weakly cemented caliche fragments mostly 1/2 inch to 3 inches in diameter; calcareous; moderately alkaline; clear wavy boundary.

C3ca—22 to 60 inches; very pale brown (10YR 8/3) very gravelly loam, very pale brown (10YR 7/3) moist; massive; hard, friable; about 30 percent by volume soft masses of calcium carbonate; about 40 percent by volume caliche coated igneous pebbles and caliche fragments mostly 1/4 inch to 2 inches in diameter; calcareous; moderately alkaline.

Weakly cemented caliche is at a depth of 6 to 30 inches. Coarse fragments are limestone, sandstone, and igneous gravel mostly less than 3 inches in diameter and coated with caliche. Some pedons have a few fragments up to 5 inches in diameter. Coarse fragments in the control section have an average volume of 40 to 60 percent. Content of clay is 10 to 18 percent. The soil is calcareous and moderately alkaline throughout.

The A horizon is 3 to 5 inches thick and is light brown, light brownish gray, reddish yellow, pinkish gray, or pale brown. It is gravelly loam, very gravelly loam, gravelly sandy loam, or very gravelly sandy loam.

The C1 horizon is light brown, pale brown, light brownish gray, pinkish gray, or very pale brown. It is gravelly loam, very gravelly loam, gravelly sandy loam, or very gravelly sandy loam.

The Cca horizon is very pale brown, pale brown, pink, brown, or pinkish white. It is very gravelly loam or very gravelly sandy loam. The volume of coarse fragments ranges from 40 to 70 percent.

## Orla series

The Orla series consists of well drained, loamy soils on uplands. These soils are shallow over gypsiferous beds. They formed in saline, calcareous, gypsiferous materials from ancient salt lakes. Slope ranges from 0 to 3 percent.

Typical pedon of Orla clay loam in an area of Orla association, nearly level, from the intersection of Inter-state 20 and U.S. Highway 285 in Pecos, 0.3 mile south on

U.S. Highway 285, 0.45 mile west on a dirt road, 5.15 miles south, and 100 feet east, in range:

A1—0 to 5 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak very fine subangular blocky structure; slightly hard, friable; many roots; saline; calcareous; moderately alkaline; abrupt wavy boundary.

C1cacs—5 to 23 inches; very pale brown (10YR 8/3) silt loam, very pale brown (10YR 7/3) moist; massive; very hard, friable; few roots; porous; about 70 percent by volume gypsum and calcium carbonate; saline; calcareous; moderately alkaline; clear wavy boundary.

C2cs—23 to 60 inches; brown (10YR 5/3) sandy clay loam, brown (10YR 4/3) moist; massive; hard, friable; few roots; about 10 percent brownish opaque gypsum crystals 2 to 3 millimeters wide and up to 5 millimeters long; saline; calcareous; moderately alkaline.

The solum is 1 to 20 inches thick. Clay content of the 10- to 40-inch control section ranges from 18 to 35 percent. The control section is generally moist in some parts, but the soil moisture tension is greater than 15 bars more than 3/4 of the time. This soil is moderately saline to extremely saline.

The A horizon is pale brown, light brownish gray, or very pale brown loam, clay loam, or silt loam.

The C horizon is very pale brown, light brown, brown, light gray, pink, pinkish gray, or white.

## Patrole series

The Patrole series consists of deep, moderately well drained, loamy soils on flood plains. These soils formed in recent loamy and clayey alluvium. Slope is less than 1 percent.

Typical pedon of Patrole silt loam in an area of Gila-Patrole association, from the intersection of U.S. High-way 285 and Farm Road 652 in Orla, 5.2 miles northeast on Farm Road 652, 4.7 miles south on a county road, and 0.1 mile northeast on a private road, in range:

A1—0 to 7 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak very fine subangular blocky structure; slightly hard, friable; common fine roots; saline; calcareous; moderately alkaline; abrupt wavy boundary.

C1—7 to 24 inches; light brown (7.5YR 6/4) silt loam, brown (7.5YR 5/4) moist; massive; hard, friable; few fine roots; few fine pores; saline; calcareous; moderately alkaline; abrupt wavy boundary.

C2—24 to 32 inches; light brown (7.5YR 6/4) very fine sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable; few fine roots; few fine pores; distinct bedding planes; saline; calcareous; moderately alkaline; abrupt wavy boundary.

C3—32 to 45 inches; reddish gray (5YR 5/2) clay, very dark reddish gray (5YR 4/2) moist; strong very fine subangular blocky structure; very hard, very firm, plastic; shiny ped faces; few fine salt deposits; saline; calcareous; moderately alkaline; abrupt wavy boundary.

C4—45 to 60 inches; pink (7.5YR 7/4) loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable; saline; few fine salt deposits; calcareous; moderately alkaline.

The fine silty horizons over the clayey horizon are 21 to 36 inches thick. The soil ranges from moderately saline to extremely saline. The upper part of the control section has a clay content of 18 to 30 percent and the lower part has a clay content of 40 to 60 percent.

The A horizon is 6 to 10 inches thick. It is grayish brown, pinkish gray, brown, or light brownish gray silt loam, loam, or silty clay loam.

The combined thickness of the C1 and C2 horizons ranges from 11 to 30 inches. They are light brown, brown, pale brown, or pinkish gray silt loam, very fine sandy loam, or silty clay loam.

The C3 horizon ranges from 6 inches to more than 40 inches in thickness. It is brown or reddish gray clay or silty clay. Some pedons have thin lenses of silt loam, very fine sandy loam, or loam 1 /8 inch to 2 inches thick.

The C4 horizon, if present, is pink, light brown, pale brown, or brown loam or silty clay loam.

## Pecos series

The Pecos series consists of deep, moderately well drained, clayey soils on flood plains. These soils formed in calcareous, stratified, clayey alluvium. Slope is less than 1 percent.

Typical pedon of Pecos silty clay in an area of Pecos silty clay, saline, from the intersection of U.S. Highways 80 and 285 in Pecos, 1.2 miles east on U.S. Highway 80, 0.4 mile south on a county road, and 0.4 mile east on a private road, in a cultivated field on the north side of the road:

Ap—0 to 6 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak very fine subangular blocky structure; very hard, very firm; many roots; common fine pores; saline; calcareous; moderately alkaline; abrupt smooth boundary.

A1—6 to 18 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; very hard, very firm; many roots; few fine pores; saline; few fine salt deposits; calcareous; moderately alkaline; abrupt wavy boundary.

C1—18 to 43 inches; light gray (10YR 6/1) clay, gray (10YR 5/1) moist; massive; extremely hard, extremely firm; about 20 percent by volume visible gypsum and other salt deposits; saline; calcareous; moderately alkaline; abrupt wavy boundary.

C2—43 to 60 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; massive; hard, firm; saline; about 10 percent by volume gypsum and other salt deposits; calcareous; moderately alkaline.

Depth of the soil to a contrasting textural layer is over 40 inches. Salinity ranges from moderate to extreme. The average clay content of the 10 to 40-inch control section ranges from 35 to 55 percent.

The A horizon is 10 to 28 inches thick. It is grayish brown, brown, dark reddish gray, or dark grayish brown silty clay, silty clay loam, or clay loam.

The C horizon is light gray, light brownish gray, reddish brown, pale brown, light reddish brown, reddish yellow, or brown clay or silty clay. Some pedons have thin bedding planes. Most pedons have a layer of loam, silt loam, or silty clay loam between a depth of 40 and 60 inches. The volume of visible gypsum and other salts ranges from 5 to 40 percent in most pedons. A few faint mottles are present in some pedons.

## Phantom series

The Phantom series consists of deep, well drained soils that formed in clayey sediment. These soils are nearly level soils on flats in wide valleys and gently sloping soils on alluvial fans and flood plains of mountain draws. Permeability is moderately slow. Slope is 0 to 3 percent.

Typical pedon of Phantom clay loam in an area of Phantom association, nearly level, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 4,4 miles southwest on U.S. Highway 290, 2.7 miles south on Texas Highway 17, and 200 feet east, in range:

A11—0 to 9 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; compound weak coarse platy and subangular blocky structure; hard, firm; common fine roots; few cracks about 112 inch wide; calcareous; moderately alkaline; abrupt smooth boundary.

A12—9 to 19 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong fine angular blocky structure; hard, firm; common fine roots; few cracks about 1/2 inch wide; calcareous; moderately alkaline; gradual smooth boundary.

A13—19 to 44 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard, very firm; few very fine, hard concretions of calcium carbonate; few roots; few cracks about 1/2 inch wide at a depth of 30 inches; calcareous; moderately alkaline; gradual smooth boundary.

B—44 to 60 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; hard, firm; calcareous; moderately alkaline.

The solum is 40 to more than 60 inches thick. These soils have a COLE of 0.07 to 0.09, and when dry they have cracks 1/2 to 1 inch wide that extend to a depth of 20 to 36 inches. Reaction is neutral to moderately alkaline.

The A horizon is 20 to 50 inches thick. It is grayish brown, dark grayish brown, or brown clay loam, silty clay, or clay. Clay content of the 10 to 40-inch control section is 35 to 60 percent.

The B horizon is grayish brown, light brownish gray, pale brown, or light brown. It is clay loam or clay, and in some areas has a few pebbles, cobbles, and stones.

## Reakor series

The Reakor series consists of deep, well drained, loamy soils on outwash plains and uplands. These soils formed in calcareous, loamy alluvium. Slope ranges from 0 to 3 percent.

Typical pedon of Reakor loam in an area of Reakor association, nearly level, from the intersection of U.S. Highways 80 and 285 in Pecos, 10.3 miles northwest on U.S. Highway 285, 2.2 miles southwest on an oilfield road, and 50 feet south, in range (fig. 12):

A1—0 to 8 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 4/4) moist; weak very fine subangular blocky structure, platy in upper 1 inch; hard, friable; many roots; calcareous; moderately alkaline; diffuse smooth boundary.

B21—8 to 24 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; moderate fine subangular blocky structure; hard, friable; many roots; few threads of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B22ca—24 to 36 inches; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; moderate fine subangular blocky structure; hard, firm; few roots; about 5 percent by volume visible concretions, soft masses, and threads of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

C1—36 to 60 inches; pink (7.5YR 7/4) clay loam, strong brown (7.5YR 5/6) moist; massive; hard, firm; few roots; calcareous; moderately alkaline.

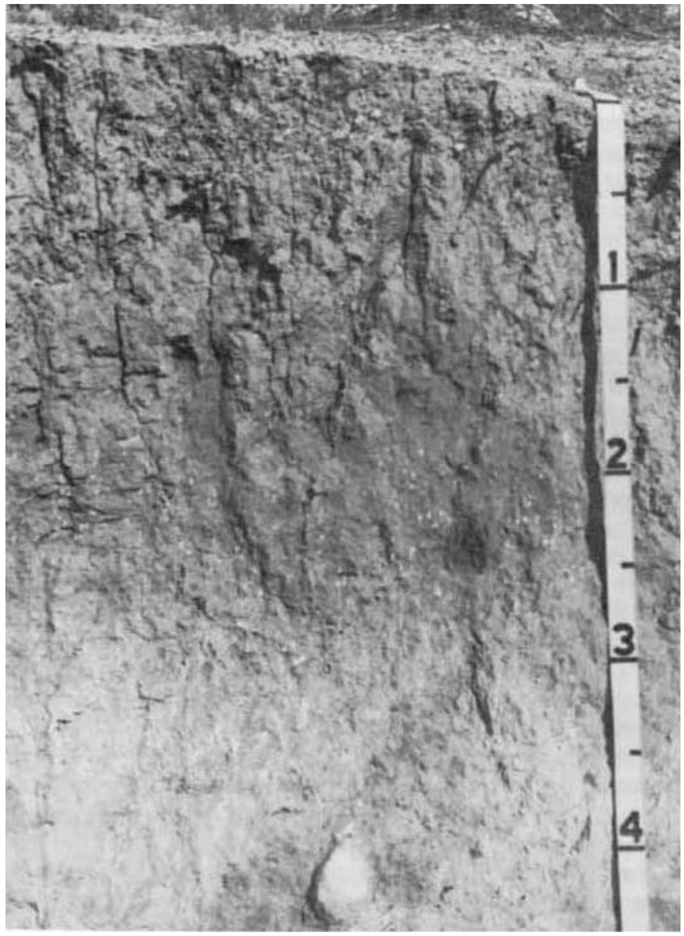


***Figure 12*—A profile of Reakor loam**

The depth to the calcic horizon is 20 to 40 inches. Clay content of the control section is 20 to 35 percent.

The A horizon is grayish brown, light brownish gray, pale brown, brown, or light brown. It is loam, silty clay loam, or clay loam and is 3 to 18 inches thick.

The B horizon is light brown, pink, pale brown, light yellowish brown, or brown. It is silty clay loam or clay loam and is 8 to 34 inches thick. The calcic horizon has 5 to 35 percent by volume visible calcium carbonate concretions, soft masses, films, and threads.

The C horizon is very pale brown, pale brown, brown, pinkish white, or pink loam or clay loam.

## Reeves series

The Reeves series consists of moderately deep, well drained, loamy soils on uplands. These soils formed in loamy alluvium and beds of gypsum material. Slope is 0 to 2 percent.

Typical pedon of Reeves clay loam, 0 to 1 percent slopes, from the intersection of Texas Highway 17 and Interstate 20 in Pecos, 10.7 miles west on Interstate 20, exit on Shaw Road, 200 feet north from the Missouri Pacific Railroad track, and 100 feet west, in a cultivated field:

Ap—0 to 11 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; surface crust has dry color of very pale brown (10YR 7/3); massive; slightly hard, friable; calcareous; moderately alkaline; abrupt smooth boundary.

B2ca—11 to 33 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak very fine subangular blocky structure; slightly hard, friable; few fine soft concretions and threads of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

Ccacs—33 to 60 inches; very pale brown (10YR 7/4) clay loam, light yellowish brown (10YR 614) moist; massive; hard, friable; about 50 percent by volume visible calcium carbonate and gypsum deposits; calcareous; moderately alkaline.

The depth to the gypsic horizon is 20 to 36 inches. Clay content of the control section ranges from 18 to 30 percent. These soils are calcareous and moderately alkaline throughout.

The A horizon is 4 to 12 inches thick. It is pale brown, yellowish brown, brown, light brown, pink, light gray, light brownish gray, very pale brown, or light yellowish brown. The A horizon is clay loam, silty clay loam, or loam.

The Bca horizon is 12 to 30 inches thick. It is brown, light yellowish brown, reddish yellow, pale brown, light brown, or yellow clay loam, silty clay loam, or loam.

The Ccacs horizon is brown, very pale brown, pink, white, pinkish white, light yellowish brown, light brown, or reddish yellow. It is loam or clay loam. The volume of visible gypsum and calcium carbonate ranges from 20 to 90 percent.

## Rockhouse series

The Rockhouse series consists of deep, well drained, loamy to very gravelly soils on flood plains along draws.

These soils formed in very gravelly, cobbly, and stony alluvium from igneous hills and mountains. Slope is 0 to 2 percent.

Typical pedon of Rockhouse loam in an area of Bigetty-Rockhouse association, from the intersection of Interstate 10 and Farm Road 2903, 2 miles north of Balmorhea, 3.8 miles west on Interstate 10, 0.5 mile north on a private road, and 2.15 miles northwest on a private road, to an exposed cut in a streambank on the west side of the road:

A11—0 to 8 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, very friable; few fine roots; common fine pores; about 5 percent cobbles by volume; neutral; clear smooth boundary.

A12—8 to 15 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, very friable; few fine roots; common fine pores; about 5 percent cobbles by volume; neutral; clear smooth boundary.

C—15 to 60 inches; brown (10YR 5/3) very cobbly loamy sand, dark brown (10YR 4/3) moist; single grained; loose; few fine roots; about 90 percent by volume rounded igneous fragments (20 percent pebbles, 40 percent cobbles, and 30 percent stones); neutral.

The mollic epipedon is 10 to 17 inches thick.

The A horizon is brown or grayish brown loam, gravelly loam, or cobbly loam.

The C horizon is brown loamy sand with 90 to 95 percent by volume well rounded igneous fragments (20 to 60 percent pebbles, 30 to 40 percent cobbles, 3 to 30 percent stones, and about 2 percent boulders).

## Sanderson series

The Sanderson series consists of deep, well drained, gravelly, loamy soils on alluvial fans and foot slopes of the uplands. These soils formed in loamy, gravelly valley fill material from limestone hills. Slope ranges from 1 to 5 percent.

Typical pedon of Sanderson gravelly loam in an area of Sanderson-Upton association, gently sloping, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 8.2 miles west on U.S. Highway 290, and 100 feet south, in range:

A1—0 to 5 inches; grayish brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak very fine subangular blocky structure; slightly hard, friable; common fine roots; about 20 percent limestone fragments 1/2 inch to 2 inches in diameter; calcareous; moderately alkaline; clear smooth boundary.

B21ca—5 to 17 inches; light brownish gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; slightly hard, friable; common fine roots; few threads of calcium carbonate; about 35 percent by volume limestone fragments less than 2 inches in diameter; calcareous; moderately alkaline; clear smooth boundary.

B22ca—17 to 33 inches; light reddish brown (5YR 6/4) very gravelly loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; few films and threads of calcium carbonate; about 40 percent by volume limestone fragments less than 2 inches in diameter; calcareous; moderately alkaline; gradual smooth boundary.

C—33 to 60 inches; light reddish brown (5YR 6/4) very gravelly loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable; few very fine roots; few films and threads of calcium carbonate; about 60 percent by volume limestone fragments less than 2 inches in diameter; calcareous; moderately alkaline.

The solum is 23 to 40 inches thick. The volume of limestone fragments in the control section ranges from 35 to 55 percent.

The A horizon is 5 to 9 inches thick. It is grayish brown, light brownish gray, or brown gravelly or very gravelly loam or clay loam.

The Bca horizon is 16 to 28 inches thick. It is light brownish gray or light brown gravelly or very gravelly loam or clay loam in the upper part and very gravelly loam or clay loam in the lower part.

The C horizon is light brown, pale brown, or very pale brown. It is gravelly or very gravelly loam or clay loam.

## Saragosa series

The Saragosa series consists of shallow, poorly drained, extremely saline, loamy soils on uplands near salt lakes. These soils formed in loamy gypsiferous beds of lacustrine deposits. Slope is less than 1 percent.

Typical pedon of Saragosa clay loam in an area of Saragosa association, nearly level, from the intersection of Interstate 20 and U.S. Highway 285 in Pecos, 0.3 mile south on U.S. Highway 285, 0.45 mile west on a dirt road, 1.15 miles south on a paved road, and 85 yards east, in range:

A1sa—0 to 4 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak platy to weak fine granular structure; slightly hard, friable; few roots;

EC is 225 millimhos per centimeter; SAR is 90; calcareous; moderately alkaline; abrupt wavy boundary.

C1cssa—4 to 8 inches; white (10YR 8/2) gypsiferous material of silt loam texture, very pale brown (10YR 7/3) moist; massive; soft, friable; few roots; EC is 125 millimhos per centimeter; SAR is 102; calcareous; moderately alkaline; gradual wavy boundary.

C2cssa—8 to 17 inches; white (10YR 8/2) gypsiferous material of silt loam texture, very pale brown (10YR 7/3) moist; massive; slightly hard, firm; few roots; EC is 70 millimhos per centimeter; SAR is 58; calcareous; moderately alkaline; clear wavy boundary.

C3cssa—17 to 60 inches; white (10YR 8/2) weakly cemented gypsiferous material; massive; no roots; thin plates of brittle salt precipitate, probably gypsum, 1/8 to 1/4 inch thick and 1 inch to 6 inches across the long axis; EC is 27 millimhos per centimeter; SAR is 4.5; calcareous; moderately alkaline.

Depth to gypsiferous material is 1 /8 inch to 11 inches. Depth to the high water table ranges from 24 to 60 inches. It is higher in fall, winter, and early in spring. The soil above the high water table is extremely saline. The control section is always moist, but soil moisture tension is more than 15 bars at all times because of the salinity.

The A horizon is grayish brown, brown, light brownish gray, pale brown, light gray, very pale brown, or white. It is silt loam, loam, clay loam, or silty clay loam.

The C horizon is light gray, very pale brown, or white. The volume of gypsum and calcium carbonate ranges from 50 to 95 percent. At least 35 percent of this total is gypsum. The C horizon has a feel of silt loam or silty clay loam. Thin, weakly cemented plates of gypsum and gypsum crystals are in the lower part.

## Toyah series

The Toyah series consists of deep, well drained, loamy soils on flood plains. These soils formed in loamy alluvial material. Slope is less than 1 percent.

Typical pedon of Toyah clay loam, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 2.8 miles northeast on U.S. Highway 290, 4.2 miles east on Interstate 10, and 100 feet south, in a cultivated field:

Ap—0 to 16 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; hard, friable; very sticky; common fine roots; common very fine strongly cemented concretions of calcium carbonate; calcareous; moderately alkaline; abrupt smooth boundary.

C1—16 to 38 inches; light brownish gray (10YR 6/2) sandy clay loam, dark grayish brown (10YR 4/2) moist; few strata of slightly darker clay loam; massive; hard, friable, sticky; common fine roots; many very fine hard masses of calcium carbonate; few discontinuous bedding planes; calcareous; moderately alkaline; clear smooth boundary.

C2—38 to 60 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable, sticky; common fine hard masses of calcium carbonate; distinct bedding planes; common fine roots; calcareous; moderately alkaline.

These soils are more than 60 inches thick. They are slightly saline to strongly saline. The 10 to 40-inch control section is loam, clay loam, or sandy clay loam, and contains 20 to 35 percent clay.

The A horizon is 10 to 20 inches thick. It is brown, grayish brown, or dark grayish brown loam or clay loam.

The C horizon is pinkish gray, light reddish brown, light brown, light brownish gray, pale brown, strong brown, or grayish brown. Some pedons have thin strata and mottles of gray, olive gray, or olive. The C horizon is loam, clay loam, or sandy clay loam. Buried darkened layers are in some pedons below a depth of 30 inches. Some pedons have thin sandy strata below a depth of 40 inches.

## Upton series

The Upton series consists of very shallow to shallow, well drained, gravelly soils on uplands. These soils formed in calcareous, gravelly and loamy materials. Slope ranges from 0 to 5 percent.

Typical pedon of Upton gravelly loam, 0 to 2 percent slopes, from the Verhalen store on Texas Highway 17 in Verhalen, 0.2 mile north on Texas Highway 17, 1 mile east on a county road, 0.1 mile north on a county road, and 20 feet west, in a cultivated field:

Ap—0 to 5 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 4/3) moist; weak fine granular structure; slightly hard, very friable, slightly sticky; few fine and medium roots; 20 percent by volume caliche fragments and igneous pebbles 1/4 inch to 3 inches in diameter; calcareous; moderately alkaline; abrupt wavy boundary.

A12—5 to 12 inches; yellowish brown (10YR 5/4) gravelly loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky; few fine and medium roots; 22 percent by volume caliche fragments and igneous pebbles 1/4 inch to 3 inches in diameter; calcareous; moderately alkaline; clear wavy boundary.

B2—12 to 18 inches; light yellowish brown (10YR 6/4) gravelly loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky; 30 percent by volume caliche fragments and caliche coated igneous pebbles 1/4 inch to 3 inches in diameter; calcareous; moderately alkaline; abrupt wavy boundary.

C1cam—18 to 23 inches; pinkish white (7.5YR 8/2) caliche; indurated to strongly cemented; many imbedded igneous pebbles; gradual wavy boundary.

C2—23 to 30 inches; pink (7.5YR 8/4) gravelly loam, pink (7.5YR 7/4) moist; massive; soft, friable, sticky; about 30 percent by volume caliche coated pebbles; calcareous; moderately alkaline.

The solum is 10 to 20 inches thick. The volume of coarse fragments occurring as caliche and igneous pebbles is 20 to 35 percent.

The A horizon is 2 to 12 inches thick. It is brown, pale brown, yellowish brown, or light yellowish brown gravelly loam or gravelly clay loam.

The B horizon is 11 to 16 inches thick. It is very pale brown, yellowish brown, and light yellowish brown gravelly loam or gravelly clay loam.

The C1cam horizon is 5 to 19 inches thick and is white and pinkish white. It is laminar in the upper part and strongly cemented or indurated. The C2 horizon is white, pink, pinkish white, or pale brown, soft to weakly cemented caliche.

## Verhalen series

The Verhalen series consists of deep, moderately well drained, clayey soils on outwash plains. These soils formed in calcareous, clayey alluvium. Slope ranges from 0 to 2 percent.

Typical pedon of Verhalen clay, from the intersection of U.S. Highway 290 and Farm Road 2903 in Balmorhea, 2.8 miles northeast on U.S. Highway 290, 6.4 miles east on Interstate 10, and 100 feet south in range (fig. 13):

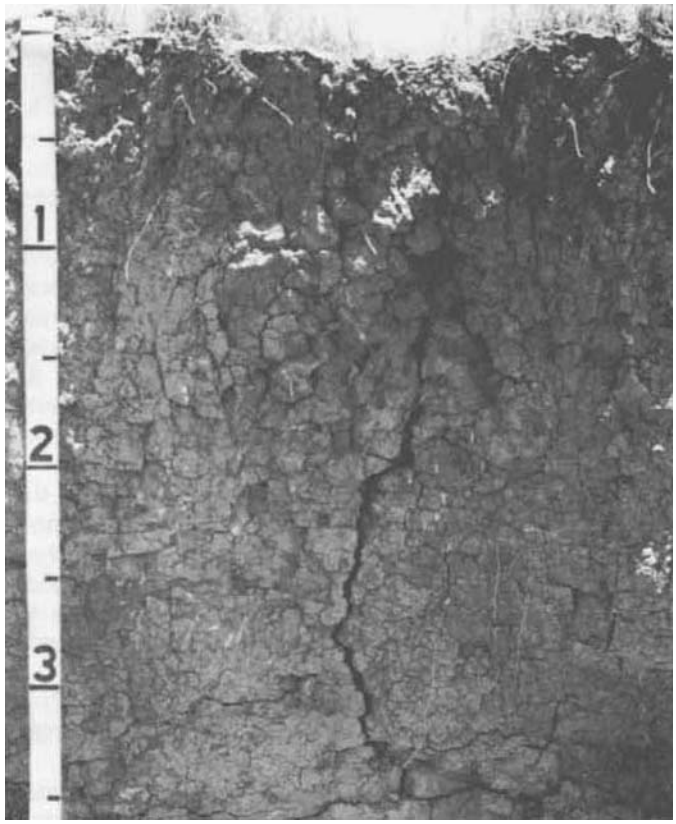


***Figure 13.—A*** **profile of Verhalen clay. Note the large crack. This clayey soil has high shrink-swell potential.**

A1—0 to 10 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure: very hard, very firm, very sticky, plastic; common fine roots; few fine tubes and pores; cracks 1 inch wide extend to lower boundary; calcareous; moderately alkaline; gradual wavy boundary.

AC—10 to 43 inches; brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; distinct intersecting slickensides; moderate medium angular blocky structure; very hard, very firm; few fine roots; few pores; cracks 0.5 inch wide extend to lower boundary; few calcium carbonate concretions; few crystals and soft masses of gypsum; calcareous; moderately alkaline; diffuse wavy boundary.

Cca—43 to 60 inches; pink (5YR 7/4) clay, reddish brown (5YR 6/4) moist; massive; very hard, very firm; 5 percent by volume soft masses and fine concretions of calcium carbonate; few fine crystals and masses of gypsum; few fine pebbles of igneous rock; calcareous; moderately alkaline.

The combined thickness of the A and AC horizons ranges from 35 to 65 inches. The soils have cracks from 0.5 inch to 2 inches wide that extend from the surface or the lower boundary of the Ap horizon to a depth of 30 to more than 40 inches. These cracks are open most of the time if the soil is not irrigated. The soil is calcareous to noncalcareous in the upper 12 inches, and calcareous below this depth. Salinity is slight to strong. The soil ranges from clay loam to clay and cobbly clay, and has between 35 and 60 percent content of clay.

The A horizon is 8 to 15 inches thick. It is reddish gray, dark reddish gray, reddish brown, brown, grayish brown, dark grayish brown, yellowish brown, or dark yellowish brown. More than half of each pedon, to a depth of 12 or more inches, has value of less than 3.5 moist.

The AC horizon is 27 to 40 inches thick. It is pinkish gray, reddish gray, dark reddish gray, light reddish brown, reddish brown, light brown, or brown. Content of calcium carbonate in the AC and C horizons varies from a few films and threads to about 30 percent soft masses.

# Formation of the soils

In this section the factors of soil formation are discussed and related to the soils in the survey area. In addition, the processes of soil formation are described.

## Factors of soil formation

Soils are the product of the interaction of five major factors of soil formation. The characteristics of a soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil formed; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the factors of soil formation have acted on the soil material.

All of the factors of soil formation are important in the genesis of every soil; some have had more influence than others in most soils. The factors are discussed in the following paragraphs.

### Parent material

Parent material refers to the unconsolidated material from which a soil forms. It largely determines the chemical and mineralogical composition of a soil. The soils of Reeves County formed in parent materials of Permian, Cretaceous, Tertiary, Quaternary, and Recent (Holocene) ages.

Permian materials of the Rustler and Castilla Formations influenced the soils in the extreme northwestern part of the county. Both formations are high in gypsum content. Some Holloman and Reeves soils formed in gypsum beds.

Cretaceous materials are mainly limestone of the Gulfian and Comanchean Formations exposed in the south-western part of the county. The gently sloping to steep land surface is benched hills and ridges underlain by limestone bedrock. Ector and Lozier soils formed in this sediment.

Tertiary materials are mainly igneous rock of the Eocene Formation. These areas are in the extreme southern part of the county in the Davis Mountains. Brewster soils formed in this material.

Quaternary materials make up most of the county. The sediment is in valley fills and on limestone hills and ridges. In these areas are Hoban, Reakor, Reeves, and Hodgins soils which continue to receive sediment from the hills and mountains. Older soils, such as Delnorte, Nickel, and Upton soils, developed in Quaternary sediment of mixed origin (igneous and limestone racks). These soils have petrocalcic horizons.

Boracho, Bigetty, Verhalen, Phantom, Limpia, Mitre, Rockhouse, and Toyah soils formed in Quaternary deposits from igneous rocks. These soils are on footslopes and in valley fills. The parent material of most of the soils on the flood plains of the Pecos River consist of fluviatile terrace deposits of the Quaternary Age.

Some of the deposits on lower-lying flood plains have been reworked and new sediment has been laid down. This material is of Recent age. The moderately alkaline and saline Gila, Arno, Patrole, Pecos, and Toyah soils formed in these deposits. Orla, Saragosa, and some Hoban, Holloman, and Reeves soils developed in areas of Recent deposits of limestone precipitated over gypsum in ancient saline lakes.

### Climate

The semi-and climate of Reeves County has had a definite effect on soil formation. Rainfall, evaporation, temperature, and wind are some of the important climatic elements. The soils are seldom wet below the root zone. The average annual rainfall ranges from about 9 inches in the lower elevations to about 13 inches in the higher elevations. The limited rainfall has not been great enough to leach bases from the soils. As a result, most of the soils have a layer in which calcium carbonate has accumulated.

Summer temperatures are high and winter temperatures are generally moderate. The high temperatures and low rainfall have limited the accumulation of organic matter in the soils.

For more information about the climate, see the section, "General nature of the county."

### Plant and animal life

Plants, earthworms, insects, animals, micro-organisms, and men have contributed to the development of soils. Gains or losses of organic matter, nitrogen, and plant nutrients, and changes in soil structure and porosity are all affected by living organisms.

Plants played a major role in soil development in Reeves County. The fibrous root system of grasses contributed large amounts of organic matter to the soils. Roots of grasses and shrubs have decayed and left pores and holes that serve as passageways for water.

Earthworms, insects, rodents, and other animals have worked and mixed the soil layers. Worms hasten the decay of organic matter. Worm casts improve the soil structure and aid the movement of water and the growth of plant roots. Fungi, bacteria, and other micro-organisms help to decay organic matter and release nutrients from minerals making them available to plants.

The activities of man have affected soil development. By fencing the range and allowing heavy grazing, man has changed the character of the vegetation. The kinds of grasses now growing are shorter, thinner, and less palatable. They return less organic matter to the soils. Tillage, irrigation with saline water, and other cultural practices have affected soil development. Construction of buildings and roads also alters soils.

### Relief

Relief or topography influences soil development through its effect on drainage and runoff. The land surface of Reeves County ranges from nearly level to steep.

If the other factors of soil formation are equal, the degree of profile development depends on the depth of penetration of moisture and on geologic erosion. Nearly level soils on uplands that receive runoff from higher adjacent areas, such as Dalby, Hoban, Reeves, Reakor, Hodgins, and Verhalen soils, generally have weak to moderate soil development as shown by their cambric and calcic horizons. Nearly level to rolling soils on up-lands that do not receive runoff and that have little moisture penetration, such as Delnorte, Mitre, Nickel, and Upton soils, are shallow to very shallow and have a cemented calcic horizon or a petrocalcic horizon.

Steep soils, such as Ector, Brewster, and Lazier soils, are shallow to very shallow and have little soil development because of runoff and erosion. Nearly level, deep soils on flood plains, such as Arno, Pecos, Toyah, Patrole, Gila, and Balmorhea soils, have the least developed profiles because they are being continually built up by sediment washed in and deposited from surrounding areas.

### Time

Time is required for the formation of distinct horizons in soils. Differences in the length of time that the parent materials have been in place are generally reflected in the degree of the soil profile development.

The soils in Reeves County range from young to old. The young soils have very little profile development while the older soils have well expressed soil horizons. Arno, Pecos, Gila, and Patrole soils are examples of young soils lacking development.

Some older soils are calcareous and have a noticeable accumulation of calcium carbonate, or a calcic horizon, in the lower part of the profile. The calcium carbon-ate occurs as soft masses or concretions, such as in Hoban, Reakor, and Hodgins soils. In other soils, such as Delnorte and Upton soils, carbonate accumulations are cemented or indurated. Indurated or petrocalcic horizons probably take millions of years to form.

In other soils, such as Limpia soils, distinct accumulations of clay in the subsoil is evidence of a long time in place.

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## Glossary

**Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

**Area reclaim** (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

**Association, soil.** A group of soils geographically associated in a characteristic repeating pattern and de-fined and delineated as a single map unit.

**Available water capacity (available moisture capacity).** The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

| | *Inches* |
|---|---|
| Very low | 0 to 3 |
| Low | 3 to 6 |
| Moderate | 6 to 9 |
| High | 9 to 12 |
| Very high | More than 12 |

**Bedding planes.** Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacus-trine, or marine sediments.

**Bedrock.** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

**Calcareous soil.** A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

**Caliche.** A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

**Cemented pan.** Strongly cemented or indurated caliche layer.

**Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

**Clay film.** A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

**Coarse fragments.** Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

**Cobblestone (or cobble).** A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

**Complex slope.** Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

**Compressible** (in tables). Excessive decrease in volume of soft soil under load.

**Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry. breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

**Control section.** The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

**Corrosive.** High risk of corrosion to uncoated steel or deterioration of concrete.

**Depth to rock.** Bedrock is too near the surface for the specified use.

**Drainage class** (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

*Excessively drained.*—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

*Somewhat excessively drained.*—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

*Well drained.*—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

*Moderately well drained*—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

*Somewhat poorly drained*—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

*Poorly drained.*—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

*Very poorly drained* —Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**Droughty.** Soil holds little water, or rainfall is too low for nonirrigated farming.

**Dusty.** Soil particles detach easily and cause dust.

**Electrical conductivity (EC).** The reciprocal of the electrical resistivity. The resistivity is the resistance, in ohms, of a conductor which is 1 centimeter long and has a cross sectional area of 1 square centimeter.

Hence, electrical conductivity is expressed in reciprocal ohms per centimeter, or mhos per centimeter. It is a measure of the soluble salts in soil or water.

**Eollan soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

**Erosion.** The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

*Erosion* (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

*Erosion* (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

**Escarpment.** A steep slope or cliff separating two comparatively level or more gently sloping surfaces.

**Excess fines** (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

**Excess salts** (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

**Fast intake** (in tables). The rapid movement of water into the soil.

**Favorable.** Favorable soil features for the specified use.

**Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

**Foot slope.** The inclined surface at the base of a hill.

**Forage.** Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

**Forb.** Any herbaceous plant not a grass or a sedge.

**Gilgai.** Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of Vertisols-clayey soils having a high coefficient of expansion and contraction with changes in moisture content.

**Grassed waterway.** A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

**Gravel.** Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

**Gravelly soil material.** Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

**Green manure** (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

**Gypsiferous.** Soil containing large amounts of gypsum.

**Gypsum.** Hydrous calcium sulphate.

**Hard to pack.** Difficult to compact.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

*O horizon.—An* organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

*C horizon.*—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

*R layer.*—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

**Hydrologic soil groups.** Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

**Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

**Infiltration rate.** The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

**Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are—

*Border.*—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

*Basin.*—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

*Controlled flooding.*—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

*Corrugation.*—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip.—Water is applied slowly and under low pressure through such applicators as orifices, emitters, porous tubing, or perforated pipe on the surface of or in the soil.

*Furrow.*—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

*Sprinkler*—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

*Subirrigation.*—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

*Wild flooding.*—Water, released at high points, is allowed to flow onto an area without controlled distribution.

**Lacustrine deposit** (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

**Large stones** (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

**Leaching.** The removal of soluble material from soil or other material by percolating water.

**Liquid** limit. The moisture content at which the soil passes from a plastic to a liquid state.

**Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

**Low strength.** The soil is not strong enough to support loads.

**Mohs scale of hardness.** Empirical scale for determining the relative hardness of a mineral. Each mineral tested is rated by comparison to ten standard minerals. The standard minerals and their hardness numbers are as follows: talc (1); gypsum (2); calcite (3); fluorite (4); apatite (5); orthoclase (6); quartz (7); topaz (8); corundum (9); and diamond (10).

**Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil pro-file.

**Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many,* size—*fine, medium,* and *coarse;* and con*trast—faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

**Munsell notation.** A designation of color by degrees of the three simple variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

**Neutral soil.** A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

**Outwash plain.** A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

**Pan.** A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, hardpan, fragipan, claypan, plowpan, and traffic pan.

**Parent material.** The unconsolidated organic and mineral material in which soil forms.

**Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.

**Pedon.** The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

**Percs slowly** (in tables). The slow movement of water through the soil adversely affecting the specified use.

**Permeability.** The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

| | |
|---|---|
| Very slow | less than 0.06 inch |
| Slow | 0.06 to 0.20 inch |
| Moderately slow | 0.2 to 0.6 inch |
| Moderate | 0.6 inch to 2.0 inches |
| Moderately rapid | 2.0 to 6.0 inches |
| Rapid | 6.0 to 20 inches |
| Very rapid | more than 20 inches |

**Phase, soil.** A subdivision of a soil series based on features that affect its use and management. For example, slope, differences in slope, stoniness, and thickness.

**pH value.** A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

**Piping** (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

**Plasticity index.** The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

**Plastic limit.** The moisture content at which a soil changes from semisolid to plastic.

**Productivity** (soil). The capability of a soil for producing a specified plant or sequence of plants under specific management.

**Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.

**Rangeland.** Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wet-lands, some deserts, tundras, and areas that sup-port certain forb and shrub communities.

**Range site.** An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

**Reaction, soil.** A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction be-cause it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

| | *pH* |
|---|---|
| Extremely acid | Below 4.5 |
| Very strongly acid | 4.5 to 5.0 |
| Strongly acid | 5.1 to 5.5 |
| Medium acid | 5.6 to 6.0 |
| Slightly acid | 6.1 to 6.5 |
| Neutral 6.6 | to 7.3 |
| Mildly alkaline | 7.4 to 7.8 |
| Moderately alkaline | 7.9 to 8.4 |
| Strongly alkaline | 8.5 to 9.0 |
| Very strongly alkaline | 9.1 and higher |

**Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

**Rooting depth** (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

**Root zone.** The part of the soil that can be penetrated by plant roots.

**Runoff.** The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

**Saline soil.** A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium. Soil salinity is commonly expressed in millimhos per centimeter of a saturated extract (EC x 1,000) defined in classes thus:

| | *Millimhos per centimeter (EC x 1,000)* |
|---|---|
| Nonsaline | 0 to 2 |
| Slightly | 2 to 4 |
| Moderately | 4 to 8 |
| Strongly | B to 16 |
| Extremely | Above 16 |

**Sand.** As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

**Seepage** (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

**Series, soil.** A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

**Shrink-swell.** The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Slickensides.** Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

**Slope.** The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

**Slow intake** (in tables). The slow movement of water into the soil.

**Small stones** (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

**Sodium-Absorption-Ratio (SAR).** A ratio for soil extracts and irrigation water used to express the relative activity of sodium ions in exchange reactions with the soil. The ion concentration is expressed in milliequivalents per liter.

**Soil.** A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Soil blowing.** Soil easily moved and deposited by wind.

**Soil moisture tension.** Measured in atmospheres (bars). One-third atmosphere is considered to be field capacity and 15 atmospheres is at the wilting coefficient (permanent wilting point of most plants).

**Solum.** The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

**Stones.** Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

**Stony.** Refers to a soil containing stones in numbers that interfere with or prevent tillage.

**Stratified.** Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

**Structure, soil.** The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Substratum.** The part of the soil below the solum.

**Surface layer.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

**Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

**Terrace** (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

**Thin layer** (in tables). Otherwise suitable soil material too thin for the specified use.

**Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

**Too clayey.** Soil slippery and sticky when wet and slow to dry.

**Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress road-banks, lawns, and land affected by mining.

**Tufa.** A porous limestone formed by deposits from springs and streams.

**Unstable fill** (in tables). Risk of caving or sloughing on banks of fill material.

**Upland** (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

**Valley fill.** In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

**Water table.** The upper limit of the soil or underlying rock material that is wholly saturated with water.

*Water table, apparent.*—A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

*Water table, artesian*—A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

*Water table, perched*—A water table standing above an unsaturated zone. In places an upper or perched water table is separated from a lower one by a dry zone.

**Wetness.-**Soil wet during period of use.

# Tables

The tables in this soil survey contain information that affects land use planning in this survey area. More current data tables may be available from the Web Soil Survey at the Tabular Data tab.

# NRCS Accessibility Statement

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